Single Aisle
TECHNICAL TRAINING MANUAL
T1+T2 (IAE V2500) (Lvl 2&3)
ELECTRICAL POWER

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ELECTRICAL POWER

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UGB13131 - U7ST0M0

SYSTEM DIAGRAM DESCRIPTION (2)

MAIN AC GENERATION

ENGINE GENERATORS

The aircraft electrical system is supplied by two engine driven GENerators regulated in speed by integrated drives.
GEN 1 is driven by engine 1.
GEN 2 is driven by engine 2.
Engine generators characteristics are:
- 115/200 volts, three phase,
- 400 Hz,
- 90 kVA.

APU GENERATOR

A third AC generator driven by the APU can replace one or both main engine generators throughout the flight envelope.
APU GEN characteristics are:
- 115/200 volts, three phase,
- 400 Hz,
- 90 kVA.

EXTERNAL POWER

A ground EXTernal PoWeR connector enables all bus bars to be supplied.
External power characteristics are:
- 115/200 volts, three phase,
- 400 Hz,
- 90 kVA minimum.

EMERGENCY GENERATOR

An AC EMERgency GEN is driven by the Ram Air Turbine (RAT) hydraulic circuit. It automatically provides emergency power in case of failure of all main aircraft generators. Emergency generator characteristics are:
- 115/200 volts, three phase,
- 400 Hz,
- 5 kVA.

AC TRANSFER

The AC transfer circuit enables AC BUS to be supplied by any generator or external power, via the Bus Tie Contactors (BTCs).
Generators are never connected in parallel on the same bus.
The two normal buses (AC BUS 1 & AC BUS 2) are supplied by the available suppliers in the following priority:
- 1: onside generator (IDG),
- 2: external Power,
- 3: APU GEN,
- 4: offside generator.

AC DISTRIBUTION

AC BUS 1/2

Each engine generator supplies its related AC BUS.

AC ESS BUS

The AC ESSential BUS is normally supplied by AC BUS 1 or by AC BUS 2 if AC BUS 1 fails.

AC ESS SHED BUS

The AC ESS SHEDdable BUS is supplied by the AC ESS BUS.

115/26V AUTO TRANSFORMER

A 115 volts to 26 volts single-phase autotransformer supplying a normal 26 volts 400 hertz sub-busbar is connected to each main busbar and to the AC ESS BUS.

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DC GENERATION

DC generation is accomplished by Transformer Rectifiers (TRs) 1 and 2. All TR characteristics are:
- maximum output of 200 A,
- 28V DC.

One essential TR unit replaces a faulty main TR to power the DC ESS BUS.

DC DISTRIBUTION

DC BUS 1/2

DC BUS 1 and DC BUS 2 are supplied by their related TR.

DC BAT BUS

The DC BATtery BUS is supplied by DC BUS 1 or by DC BUS 2 if DC BUS 1 fails. Batteries can also supply the DC BAT BUS.

DC ESS BUS

The DC ESS BUS is supplied by the DC BAT BUS. In an emergency, it is supplied either by battery 2 or by the essential TR.

DC ESS SHED BUS

The DC ESS SHED BUS is supplied by the DC ESS BUS.

BATTERIES

Two batteries can be connected to the DC BAT BUS. Each battery has its own bus, HOT BUS 1 and HOT BUS 2. They are permanently supplied. The battery capacity is 23 Ah with a nominal voltage of 24V DC.

STATIC INVERTER

On batteries only, the STATic INVerter connected to battery 1 supplies the AC STAT INV BUS.
Static inverter characteristics are:
- 115 volts, single phase,
- 400 Hz.

GROUND/FLIGHT BUSES

AC and DC GrouND/FLighT BUSes are normally supplied by the aircraft network, or directly by the external power unit, upstream of the External Power Contactor (EPC), without energizing the whole aircraft network.

GALLEYS

The main and secondary electrical circuits of the galleys are supplied by AC BUS 1 and 2. The main electrical circuits are shed in single generator operation.

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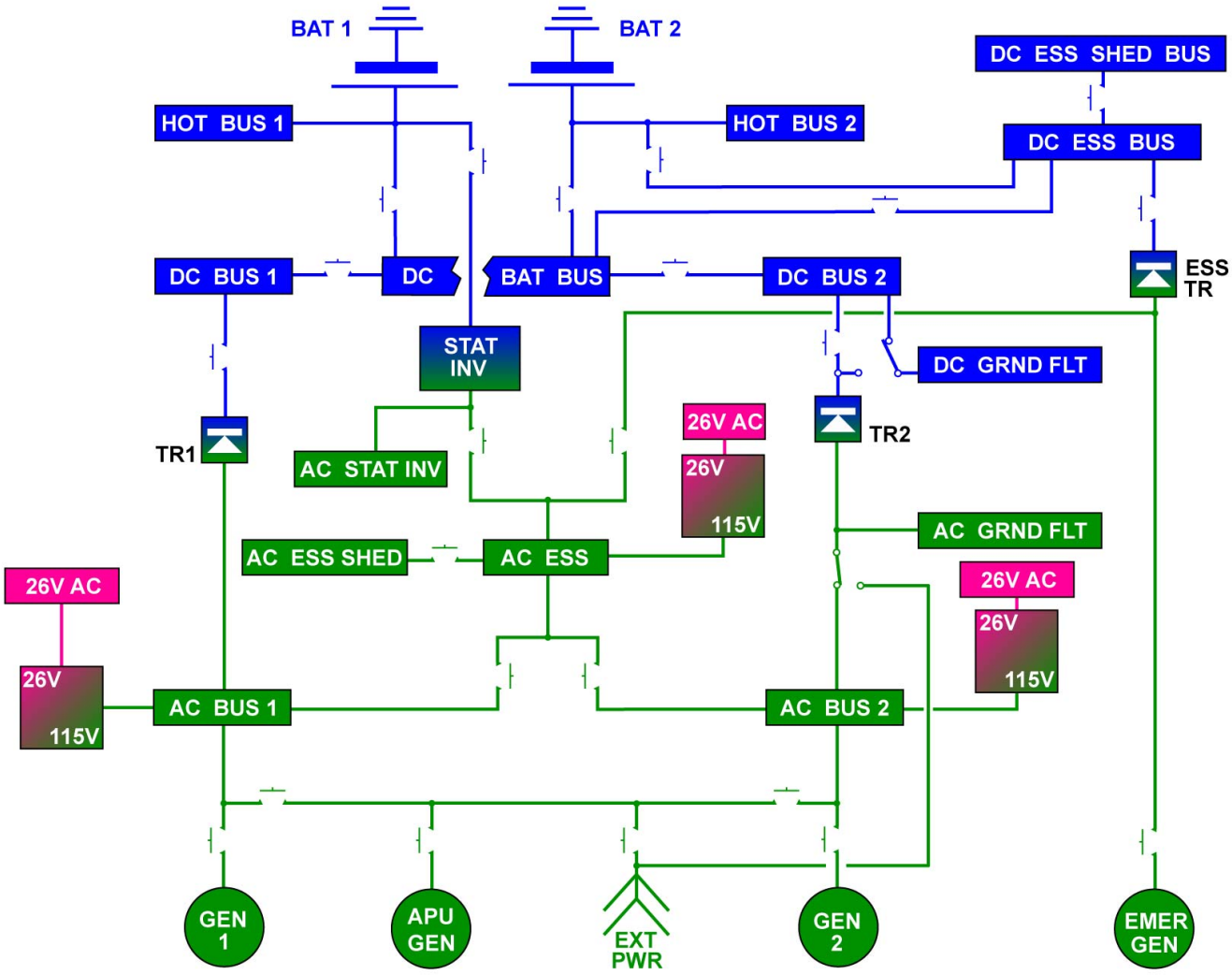

MAIN AC GENERATION ... GALLEYS

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SYSTEM DIAGRAM DESCRIPTION (2)

MAIN ELEC CONFIGURATIONS

GROUND SUPPLY

On ground, the complete circuit may be supplied by the external power unit or by the APU generator.

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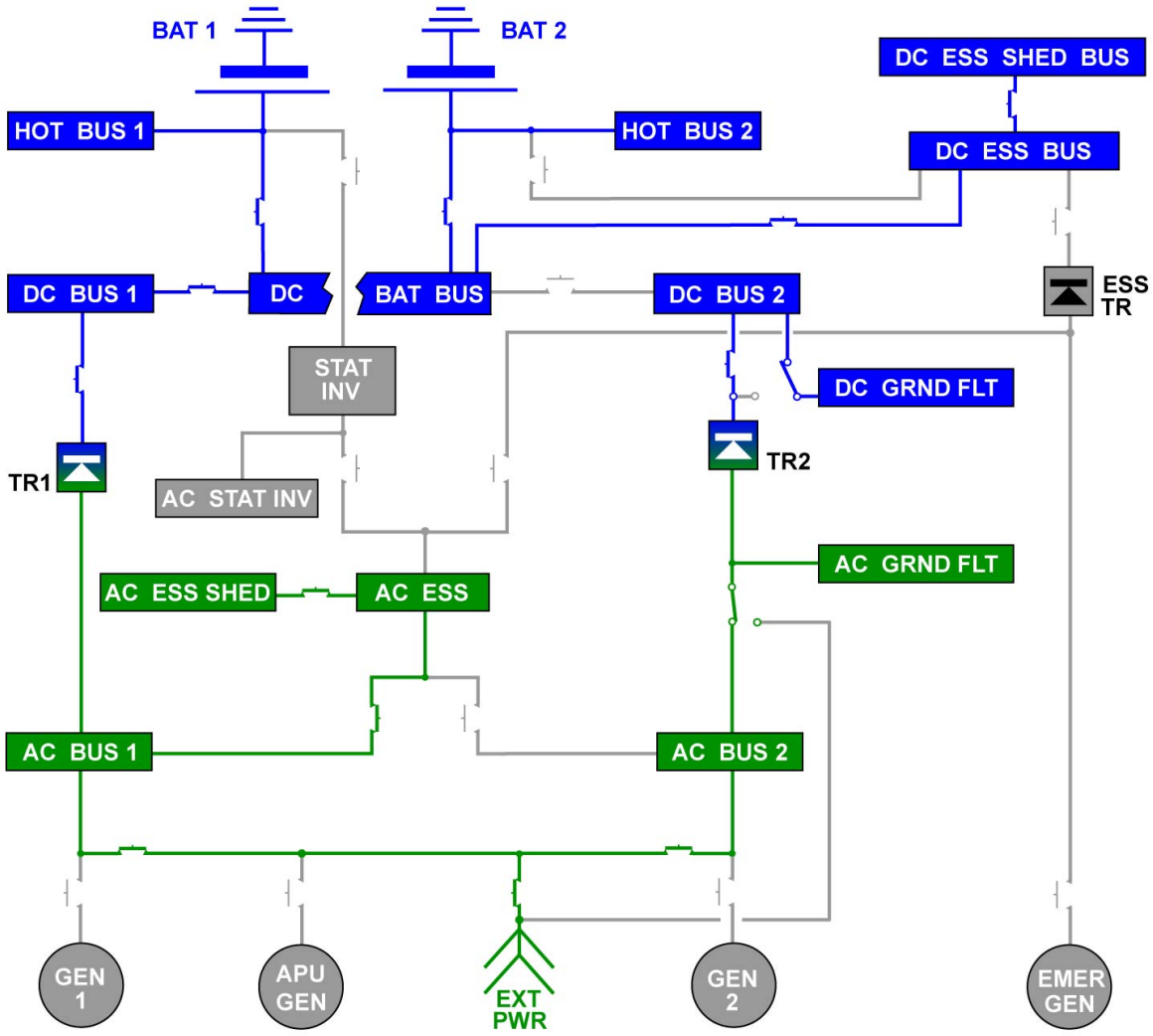

MAIN ELEC CONFIGURATIONS - GROUND SUPPLY

SYSTEM DIAGRAM DESCRIPTION (2)

MAIN ELEC CONFIGURATIONS (continued)

NORMAL FLIGHT CONFIGURATION

In normal flight configuration, each generator supplies its own distribution network via its Generator Line Contactor (GLC). The two generators are never electrically coupled.

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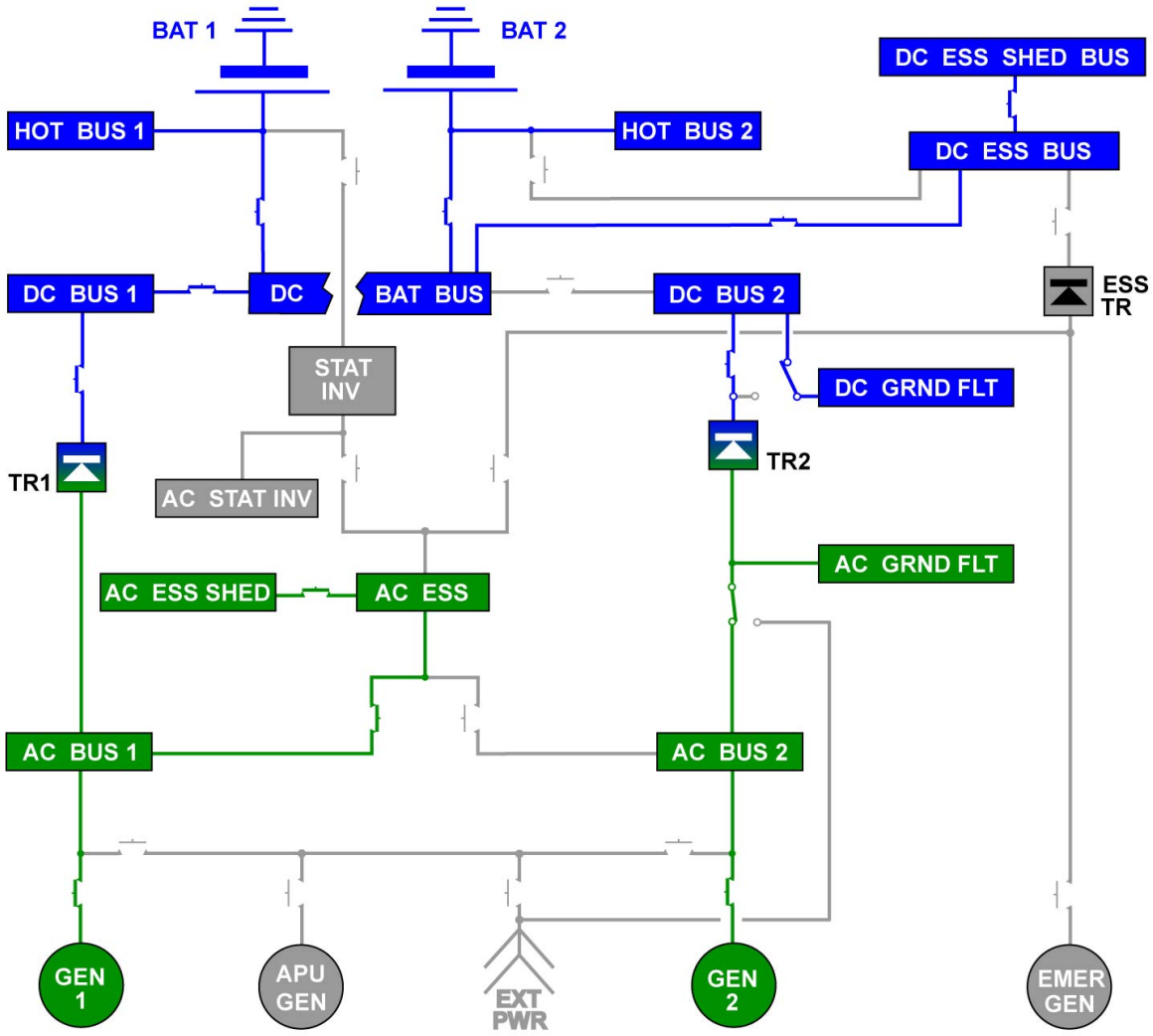

MAIN ELEC CONFIGURATIONS - NORMAL FLIGHT CONFIGURATION

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SYSTEM DIAGRAM DESCRIPTION (2)

MAIN ELEC CONFIGURATIONS (continued)

GROUND SERVICES

For ground service only, the AC and the DC GND FLT BUSes can be supplied independently from the normal circuit.

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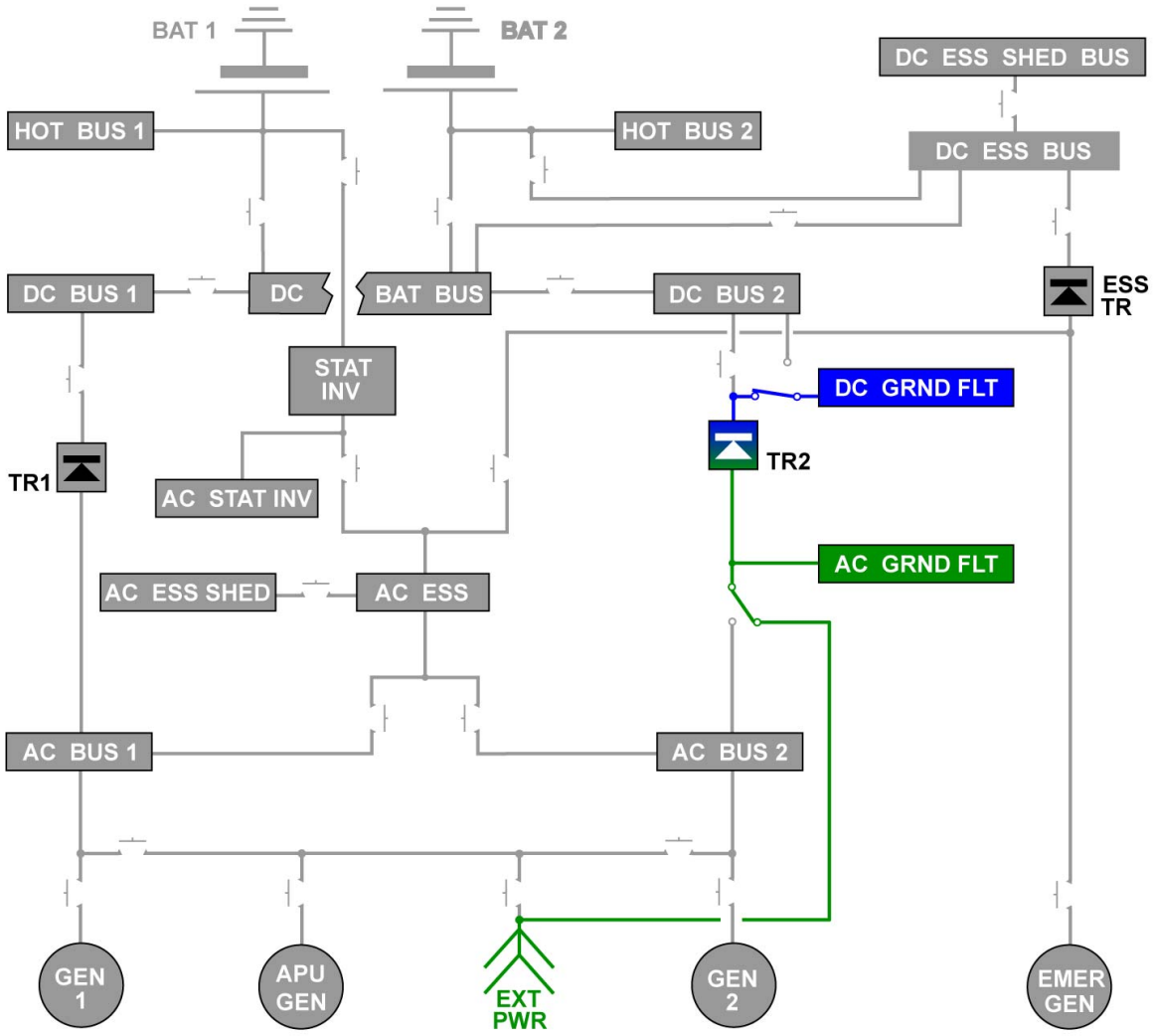

MAIN ELEC CONFIGURATIONS - GROUND SERVICES

SYSTEM DIAGRAM DESCRIPTION (2)

MAIN ELEC CONFIGURATIONS (continued)

LOSS OF MAIN GENERATORS

In flight, in case of total loss of all the main generators, and before the emergency generator connection, battery 1 will supply the AC ESS BUS, via the STAT INV and battery 2 will supply the DC ESS BUS. This is a transient configuration, during RAT extension or no emergency generator available.

When its parameters are correct and the speed is more than 100 knots, the emergency generator comes on line and supplies the AC and DC ESS BUSes, and the AC and DC ESS SHED BUSes.

When the speed is lower than 100 knots, the emergency generator is deactivated. The batteries supply the AC and DC ESS BUSes. The DC BAT BUS is recovered. When the speed drops below 50 knots, the AC ESS BUS disconnects from the static inverter.

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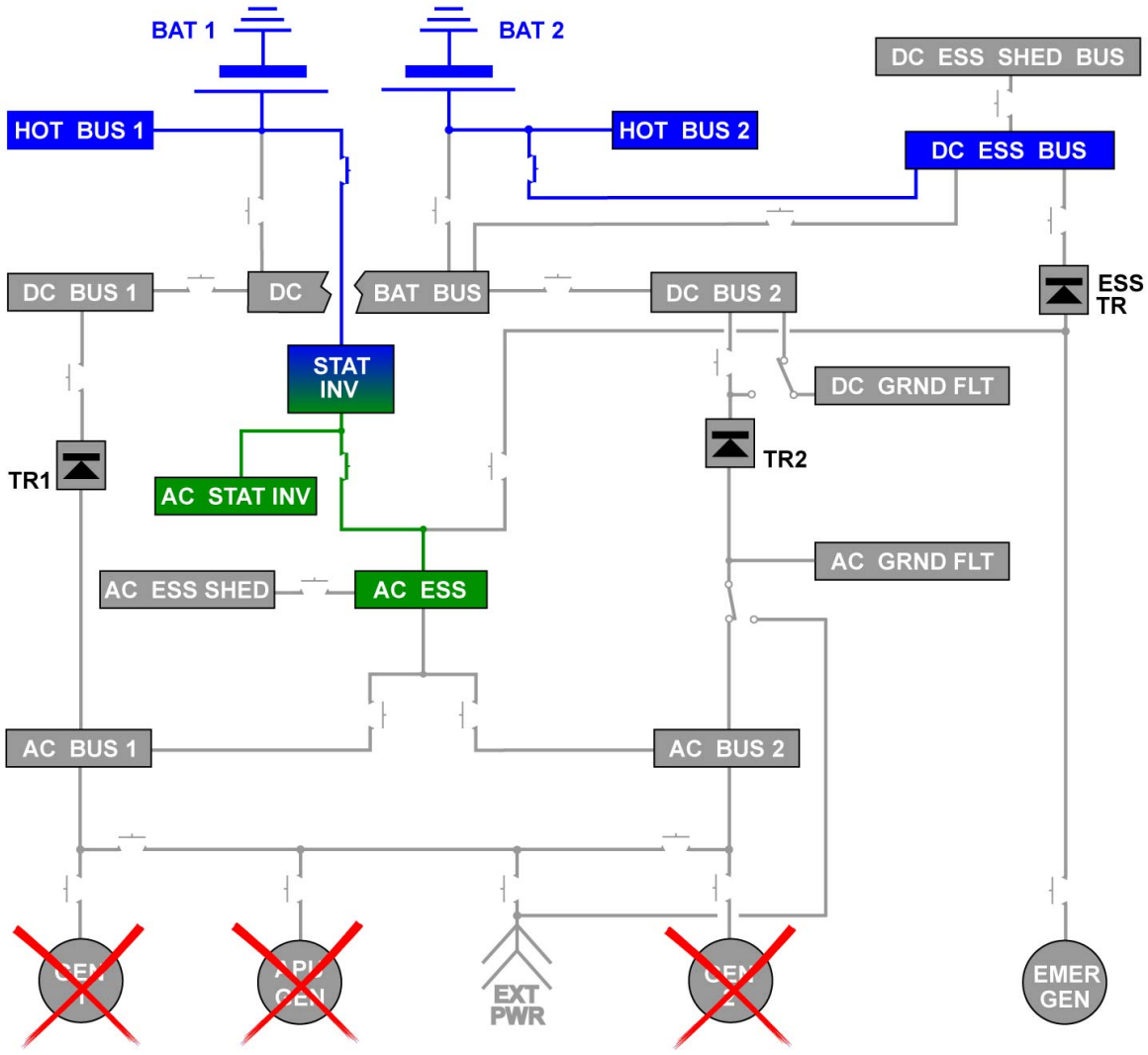
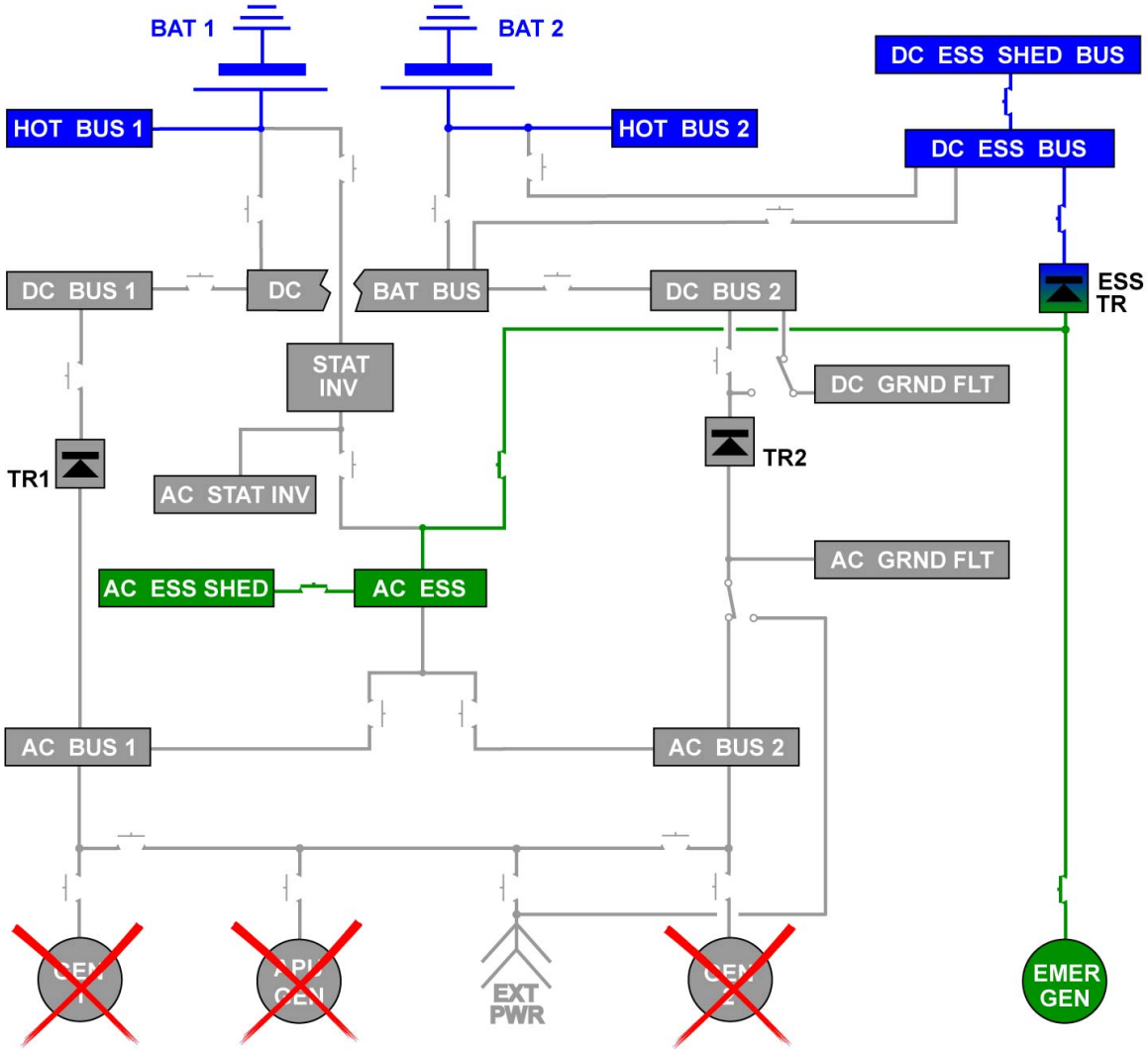
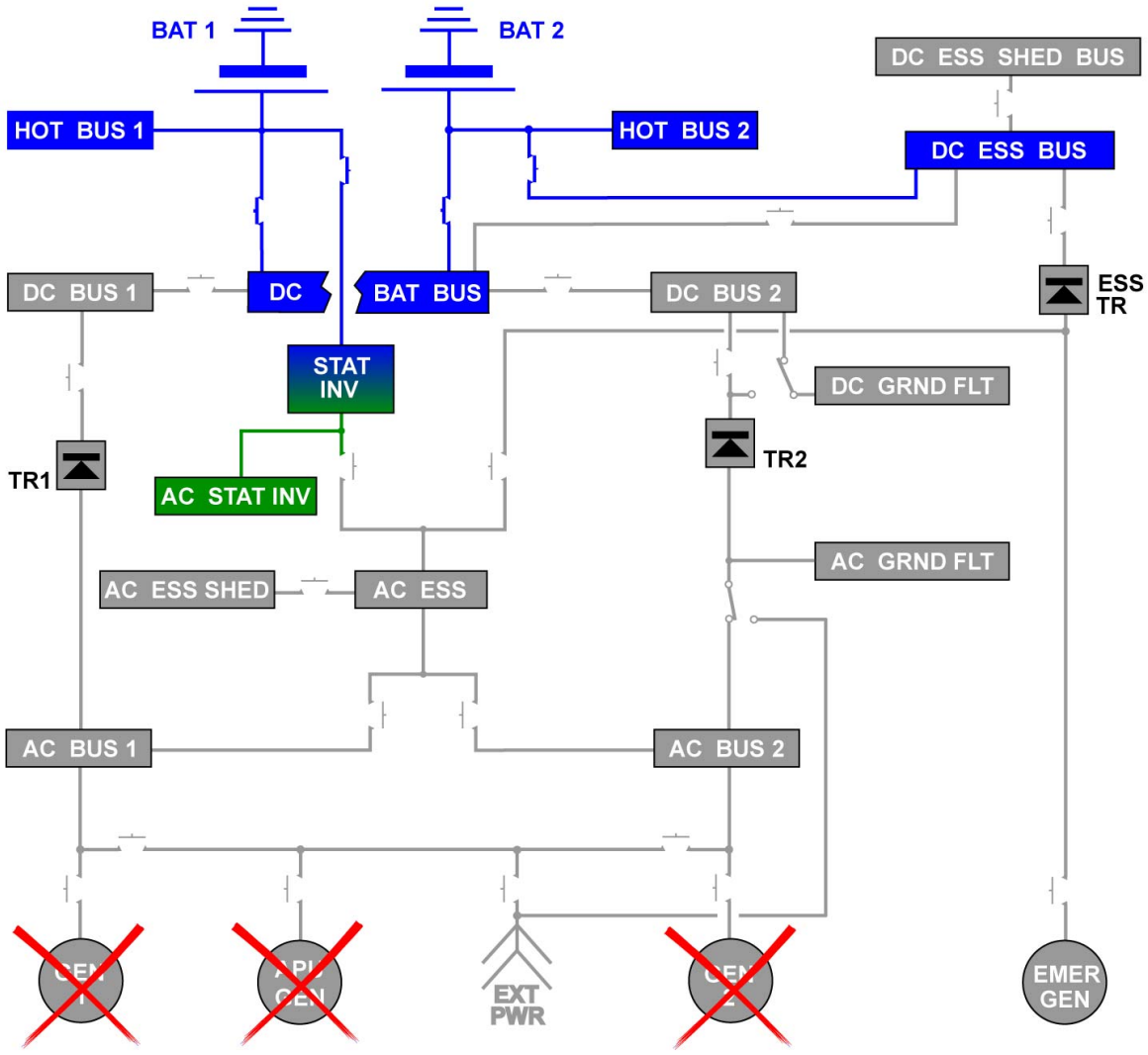


MAIN ELEC CONFIGURATIONS - LOSS OF MAIN GENERATORS



MAIN ELEC CONFIGURATIONS - LOSS OF MAIN GENERATORS



MAIN ELEC CONFIGURATIONS - LOSS OF MAIN GENERATORS

ELECTRICAL SYSTEM & CIRCUIT IDENTIFICATION (2)

SYSTEM IDENTIFICATION

An alphanumeric reference code is used to identify systems, circuits and components. The first letter of the reference code is used for system identification. A system is a set of circuits which fulfills a main function. All components not specifically related to a circuit are identified by the letter V. The second letter defines the type of component.

CIRCUIT IDENTIFICATION

The second letter of the reference code is used for circuit identification in the system. A circuit is a series of components with or without wiring, used for a specific function in a given system. All components not specifically related to a circuit are identified by the letter V.
The second letter defines the type of component. Mechanical and electrical/electro-mechanical components are identified with the letter M in place of the second circuit letter for real mechanical equipment. Four more characters, left justified and without non-significant zero, are used to identify symmetrical or multiple installations. Example: 1CC1 for Flight Augmentation Computer (FAC) 1, 1CC2 for FAC 2.

MAIN BUSBAR IDENTIFICATION

The main busbars are identified using:
- a sequence number,
- letters XP for AC busbars and PP for DC busbars,
- a phase letter when applicable.

The first number (1 or 2 or 3...) indicates the busbar number. The letters XP or PP indicate the corresponding power form. XP for alternating Current and PP for Direct Current.
Example:
- 1XP: main alternating current busbar 1(MAIN AC BUS 1),
- 1PP: main direct current busbar 1 (MAIN DC BUS 1),
- 1XP-A: MAIN AC BUS 1 phase A,
- 6PP: direct current service busbar (DC SVCE BUS).

SUB-BUSBAR IDENTIFICATION

The sub-busbars are identified in the same way as the main busbar, but with three identification digits:
- the first is identical to the number of the corresponding main busbar,
- the two following digits are the sub-busbar numbers.

Example:
- 401XP is the first sub-busbar of the AC ESS BUS,
- 601PP is the first sub-busbar of the SERVICE BUS.

It should be noted that for the AC network, the thirties are used for the 26V-400 Hz distribution.
Example: 103XP, are sub-busbar of the main busbar 1XP, but 131XP is the 26V-400 Hz distribution sub-busbar.

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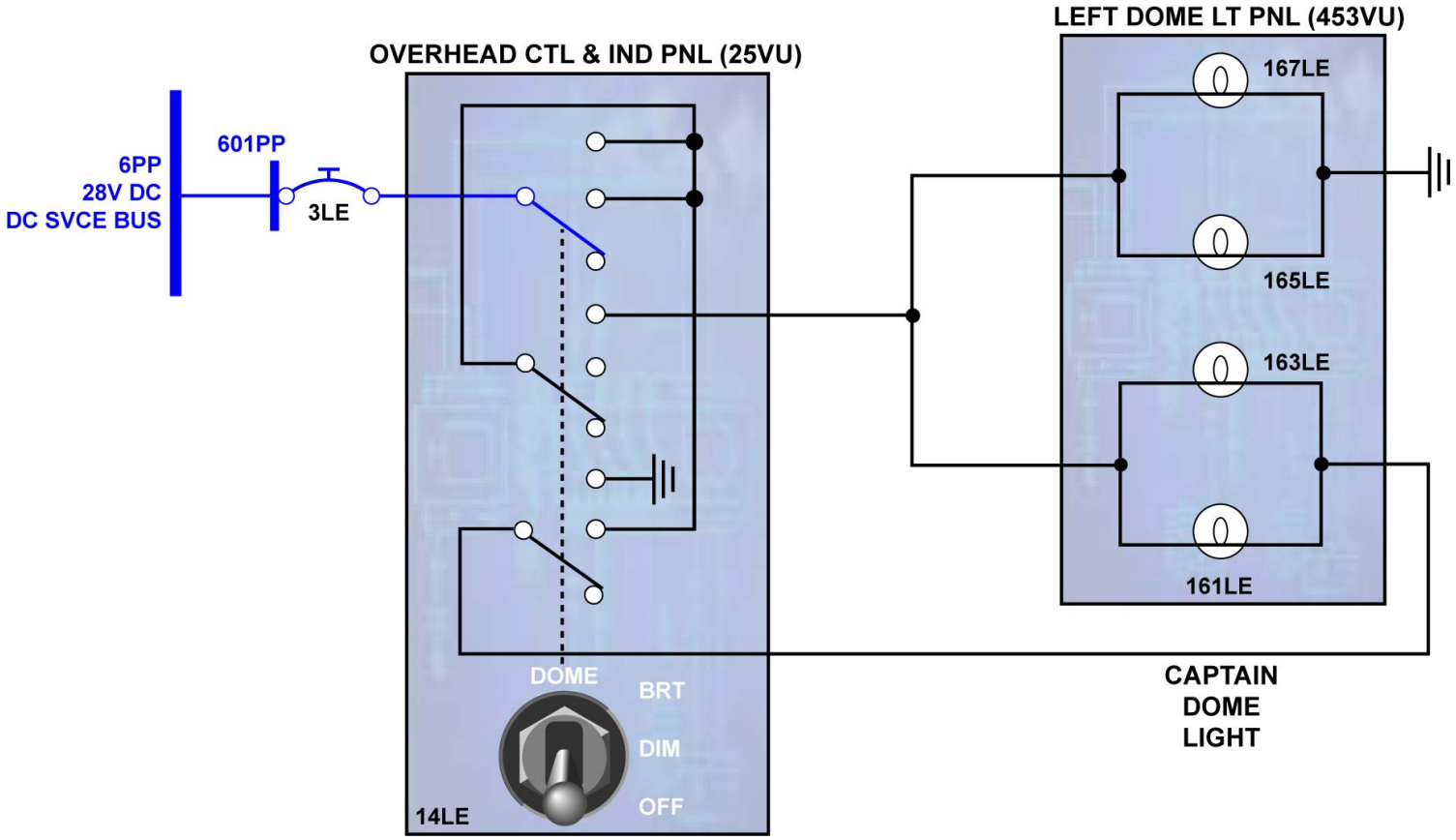

SYSTEM IDENTIFICATION ... SUB-BUSBAR IDENTIFICATION

ELECTRICAL SYSTEM & CIRCUIT IDENTIFICATION (2)

ARINC BUS IDENTIFICATION

ARINC 429 buses are numbered from 7.000 to 7.999 with the ATA 100 prefix of the corresponding system. An ARINC 429 BUS shielded cable consists of two wires: one coloured in blue and one coloured in red.

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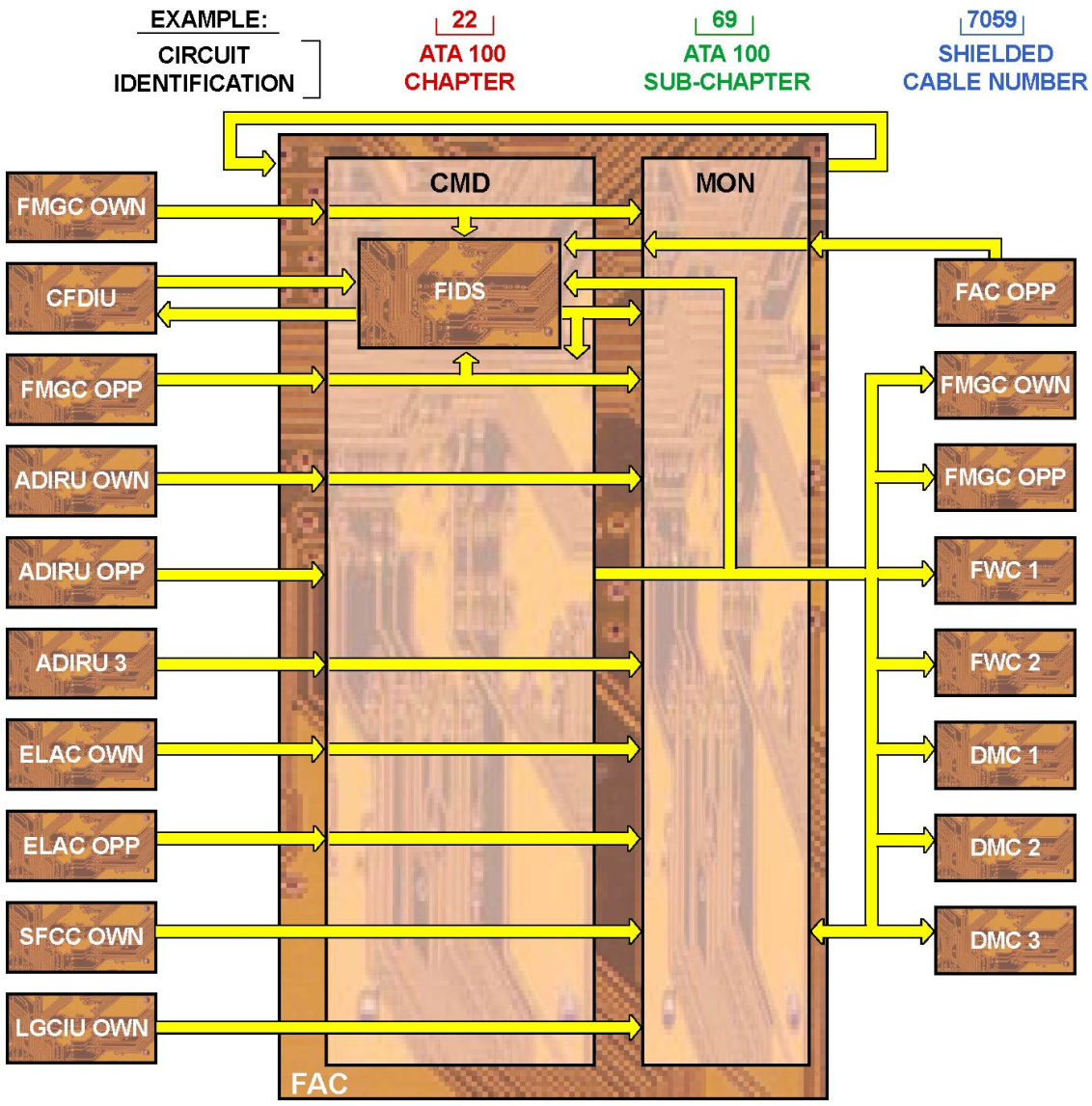

ARINC BUS IDENTIFICATION

ELECTRICAL SYSTEM & CIRCUIT IDENTIFICATION (2)

VIRTUAL BUSBAR IDENTIFICATION

Some circuit breakers do not have their supply on the busbars of the aircraft distribution network. They are directly connected to the power source. In schematic representations, this supply appears as a virtual busbar and identified as follows:
- a channel number,
- letters IW for virtual busbars followed by XP for AC busbars or PP for DC busbars.

Example: 1IWXP channel 1 of AC virtual busbar.
1IWPP channel 1 of DC virtual busbar.
Channel 1: consists of:
- 1XP-101XP-103XP-110XP-131XP,
- 1PP-101PP-103PP,
- 3PP-301PP,
- 701PP-703PP,
- 702PP-704PP,
- 901XP.

Channel 2: consists of:
- 2XP-202XP-204XP-210XP-212XP,
- 214XP-216XP-231XP,
- 2PP-202PP-204PP-206PP-208PP,
- 501PP-502PP,
- 601PP-602PP.

Channel 4: for essential channel, it consists of:
- 401XP-431XP,
- 801XP,
- 401PP,
- 801PP.

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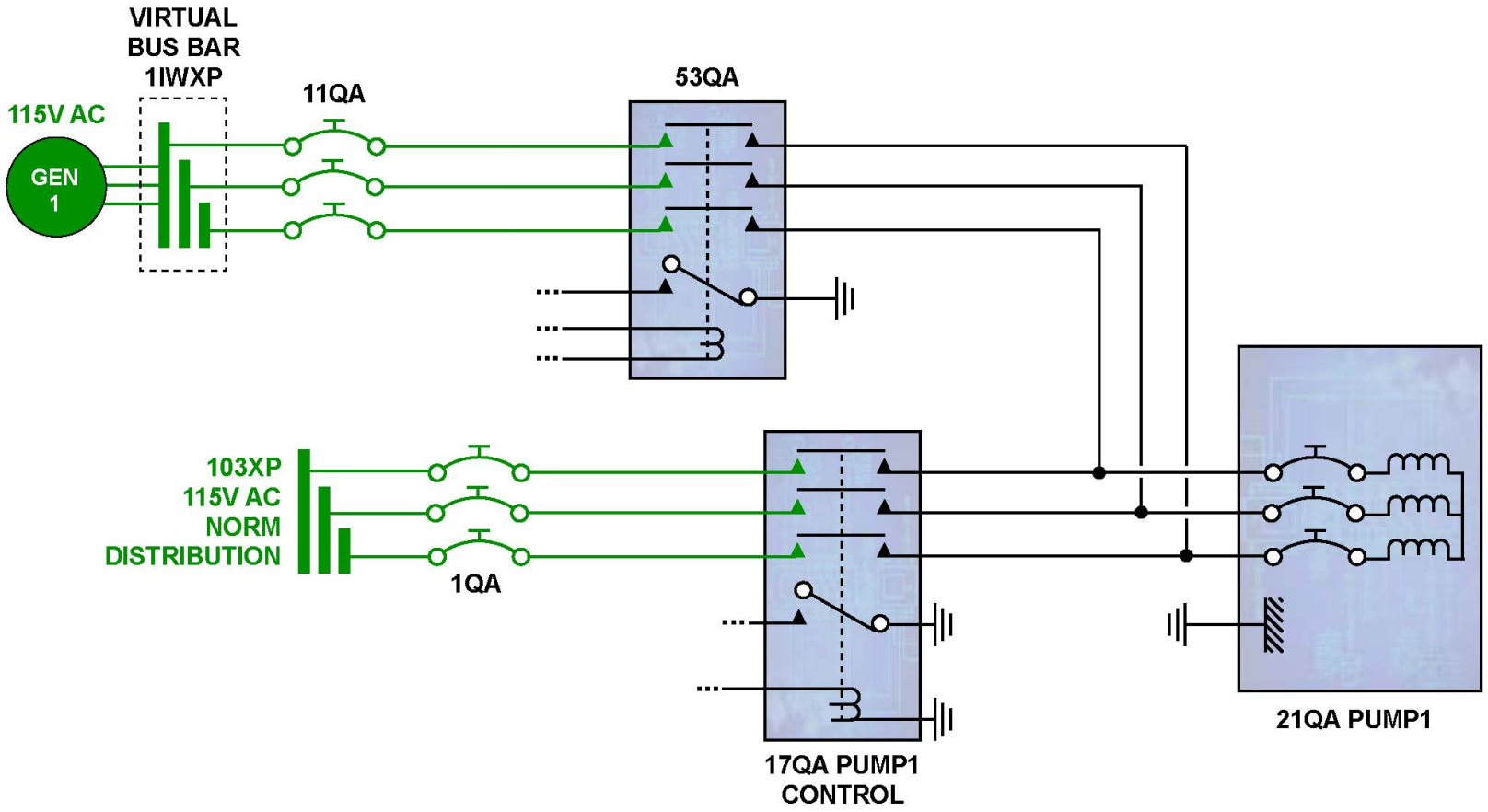

VIRTUAL BUSBAR IDENTIFICATION

ELECTRICAL SYSTEM & CIRCUIT IDENTIFICATION (2)

CONNECTOR IDENTIFICATION

Connections to components are identified by a suffix letter or two for multiple connection parts following the circuit identification.

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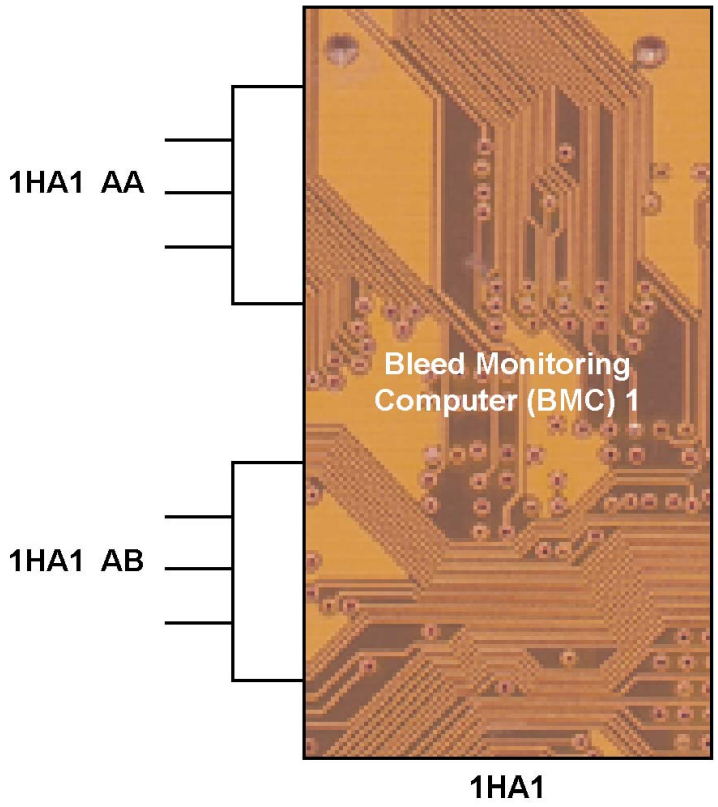

CONNECTOR IDENTIFICATION

ELECTRICAL POWER SYSTEM CONTROL & INDICATING (2)

ELEC PWR DISTRIBUTION and PRIORITIES

TR Reset, EMER GEN and ATA Review

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IDG COOLING SYSTEM (3)

GENERAL

The Integrated Drive Generator (IDG) oil cooling system consists of [an IDG oil cooler, which is part of the engine fuel/oil heat management system. The IDG oil cooler is connected to the IDG by [two oil connections (in and out).

OPERATION PRINCIPLE

A scavenge pump in the IDG pumps the oil through the [scavenge filter and the IDG oil cooler. The engine heat management system regulates the fuel flow through the IDG oil cooler to cool the IDG oil. A [charge pump provides regulated cooled oil supply pressure to [the generator and other users.
The purpose of the IDG oil cooler bypass valve is to protect the IDG oil from overcooling. Note that the cooler bypass valve is not part of the engine fuel/oil heat management system.

COLD CONDITIONS

In cold conditions (oil temp <40°C), the oil pressure increases due to high oil viscosity, then [the cooler bypass valve opens to bypass the IDG oil cooler. When IDG oil temperature is between 40°C and 70°C, [the valve is in the regulating position. This position mixes uncooled oil from the IDG and cooled oil from the IDG Oil Cooler and returns it to the IDG.

FILTER CLOGGED

A clogged filter indication is provided by a local visual [Delta Pressure pop-out Indicator (DPI). In case of clogging filter condition, [the visual indicator pops out. The DPI reset can be done in some conditions and associated with maintenance procedures. When the filter is clogged, [the relief valve opens.

TEMPERATURE AND PRESSURE MONITORING

Temperature sensors sense the IDG oil inlet and oil outlet temperatures. The Generator Control Unit (GCU) monitors the oil outlet sensor for indication on the ECAM and for advisory and overheat detection/indication. The GCU compares the oil in and oil out temperature to determine the IDG internal temperature rise. From this data, the GCU can determine if there is an internal IDG problem or an external cooling problem. An open circuit of the IDG oil outlet temperature sensor is a class 3 fault, and no flight deck effects are presented. The GCU will automatically provide the IDG oil inlet temperature plus a nominal temperature offset and display it as the oil outlet temperature on the ECAM ELEC page. [A pressure switch senses low IDG oil charge pressure. The switch is monitored by the GCU for the low oil pressure fault warning.

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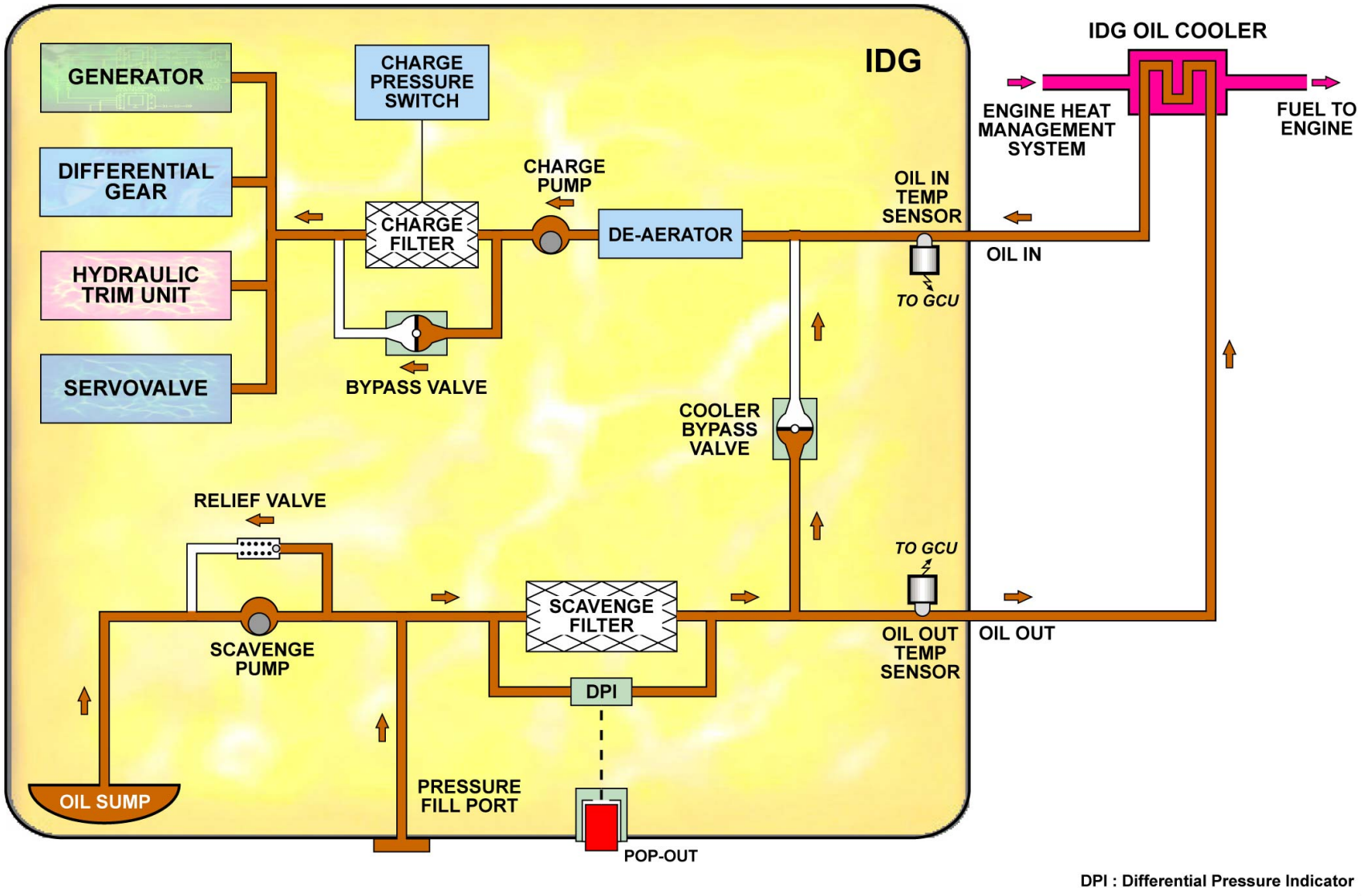

GENERAL ... TEMPERATURE AND PRESSURE MONITORING

IDG MONITORING (2)

OIL TEMPERATURE MONITORING

Integrated Drive Generator (IDG) oil temperature sensors monitor the input and the output oil temperature. If a high difference between the input and the output temperature is detected, a status message is sent to the ECAM. The difference is called a temperature rise.
The normal IDG oil inlet temperature is between 40°C to 105°C. When the oil outlet temperature reaches 142°C, an advisory mode is available on the lower ECAM. If the oil outlet temperature is equal to or more than 185°C the master caution is triggered, and a manual disconnection is written on the ECAM. If the oil outlet temperature is more than 200°C the IDG is automatically disconnected.

OIL PRESSURE MONITORING

A pressure switch operates in case of oil low pressure (lower than 140 psi) not caused by underspeed.

TEMPERATURE AND PRESSURE INDICATION

The oil outlet temperature is displayed on the ECAM System Display.
In case of high oil outlet temperature or oil low pressure, the following warnings are triggered:
- MASTER CAUTION light,
- Single chime,
- The message "ELEC IDG 1(2) OIL OVHT or ELEC IDG 1(2) OIL LO PR" is displayed on the EWD,
- The FAULT legend on the corresponding IDG P/BSW comes on amber.

The IDG must be disconnected immediately by:
- Opening the safety guard,
- Pushing the IDG P/BSW for a maximum of 3 seconds.

Note: Disconnection is only possible if the related engine is running above underspeed.

Do not push the disconnect switch if the engine speed is less than idle. The engine must be stopped for IDG reconnection.

THERMAL IDG DISCONNECTION

If the IDG disconnection is not performed at 185°C, the temperature will increase and at 200°C an automatic thermal disconnection should occur to protect the IDG. A warning message is sent to the ECAM system and a BITE MESSAGE (THERMAL DISCONNECT) is sent to the CFDS.
If this thermal disconnection fails, the message "THERMAL DISC. FAILED" is sent to the CFDS and a warning message is sent to the ECAM system.
Note: After a thermal disconnection, the IDG must be replaced.
The class 2 message "IDG OIL DELTA TEMP" is generated by the system BITE. If there is no difference between the input and the output temperature, the class 2 message "IDG COOLER" is generated by the system BITE. In both cases, the "AC GEN MAINTENANCE STATUS" is displayed on the ECAM STATUS page.

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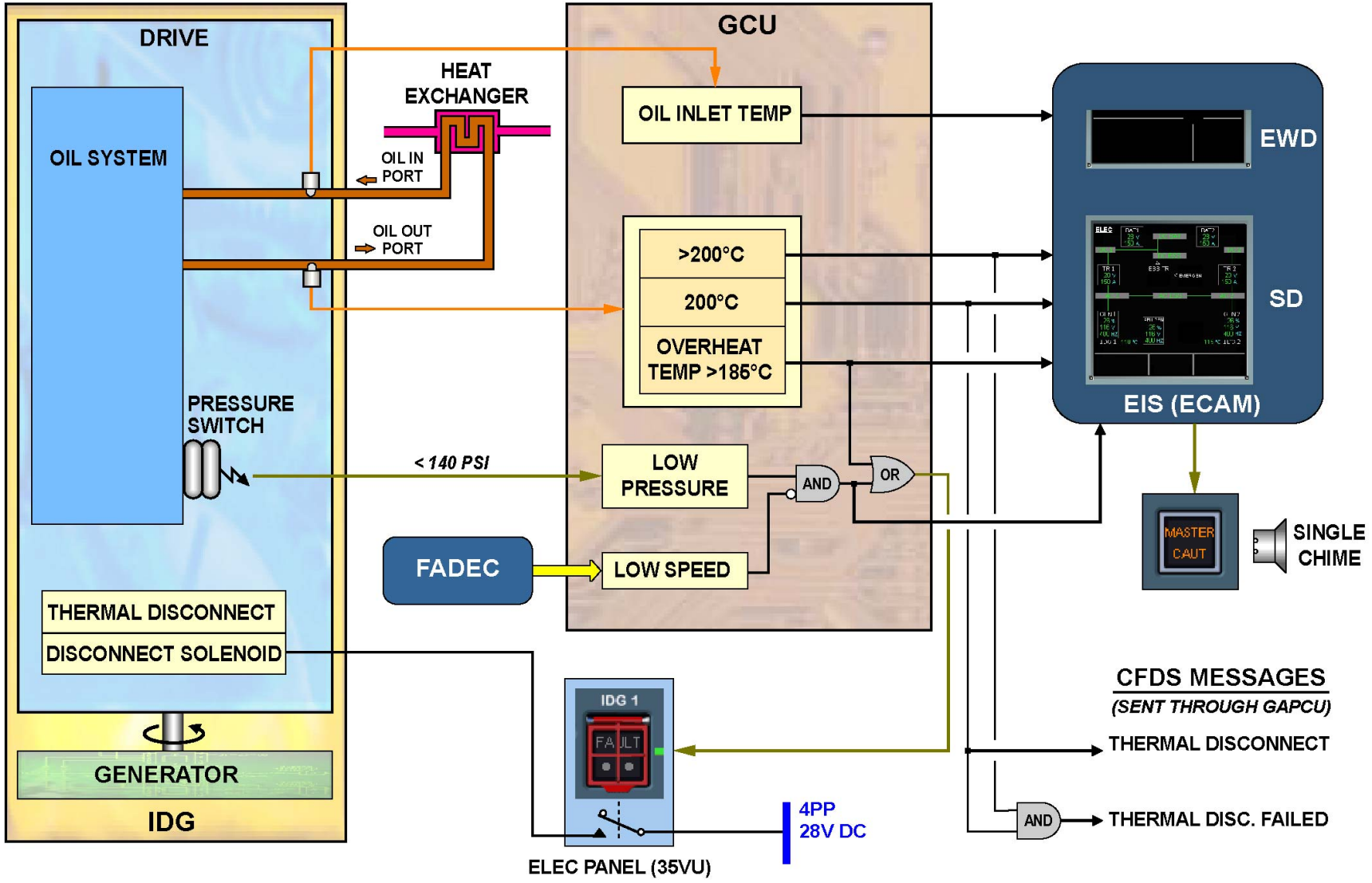

OIL TEMPERATURE MONITORING ... THERMAL IDG DISCONNECTION

IDG DRIVE PART D/O (3)

GENERAL

The Integrated Drive Generator (IDG) consists of a [Constant Speed Drive (CSD) and an [AC generator mounted side by side in a single housing. [The CSD components convert a variable input speed to a constant output speed. The CSD portion of the IDG is a hydromechanical device that adds to or subtracts from the variable input speed of the engine gearbox. The CSD performs this operation by controlled differential action to maintain the constant output speed required to drive the AC generator.
The IDG is cooled and lubricated by the oil circulation system. [The oil is cooled by an external mounted IDG oil cooler.

IDG DRIVE CONTROL

The Constant Speed Drive converts the variable input speed [provided by the engine gearbox to the constant [output speed through the CSD hydromechanical components.

IDG SPEED CONTROL

The Generator Control Unit (GCU) performs the output speed control for the IDG via the servovalve control loop whenever several conditions are met:
- [The GCU is powered-up,
- [Engine input speed to the IDG is sufficient for speed control to begin,
- No failure is present in the channel to trip the servovalve control circuit.

SERVOVALVE CONTROL LOOP

The servovalve control loop is composed of a hydraulic servovalve in the IDG and control circuitry in the [GCU which includes the ServoValve Relay (SVR). The output speed control is performed as follows: the GCU control circuit monitors [the Permanent Magnet Generator (PMG) frequency to determine the generator frequency. Note that the PMG is mounted on the IDG differential output gear. The PMG frequency signal is compared with a GCU internal frequency reference. The difference, between the actual PMG frequency and the frequency reference, [creates an error signal in the servovalve control loop circuitry. The frequency error signal is then used to control the servovalve current flow via the SVR.
The servovalve works by porting oil to an hydraulic control cylinder which determines the position of [a variable displacement hydraulic unit. Depending on the error signal, the servovalve ports more or less oil to the cylinder to maintain the desired [generator frequency (IDG output speed). As IDG speed (thus PMG frequency) decreases below the reference frequency setpoint, the servovalve supplies current increases, resulting in an IDG output speed increase.
During normal operation, the SVR is closed to allow current flow in the servovalve control loop. Under certain channel failure conditions, the SVR is opened to make sure that the servovalve drive current from the GCU is completely removed.

ENGINE SPEED SENSING

The FADEC provides the GCU with the corresponding engine speed information, which is also used for the underspeed protections.

OIL TEMPERATURE SENSING

There are two oil temperature sensors in the IDG:
- [One on the IDG oil inlet port,
- [One on the IDG oil outlet port.

Both sensors are thermistors.
The GCU uses the sensor signals to determine oil inlet, oil outlet and rise temperature for IDG protection. The temperature information is also sent to the ECAM. If oil outlet temperature is above 185°C, [the FAULT legend comes on amber on the IDG pushbutton.

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delta pRESSURE indicator (dpi)

The scavenge filter is fitted with an oil filter [Differential Pressure Indicator (DPI). If the delta pressure across the scavenge filter is 50 ± 8 psi, the [DPI (pop-out) shows the clogged position. In that case, the IDG should be serviced.

OIL PRESSURE SWITCH

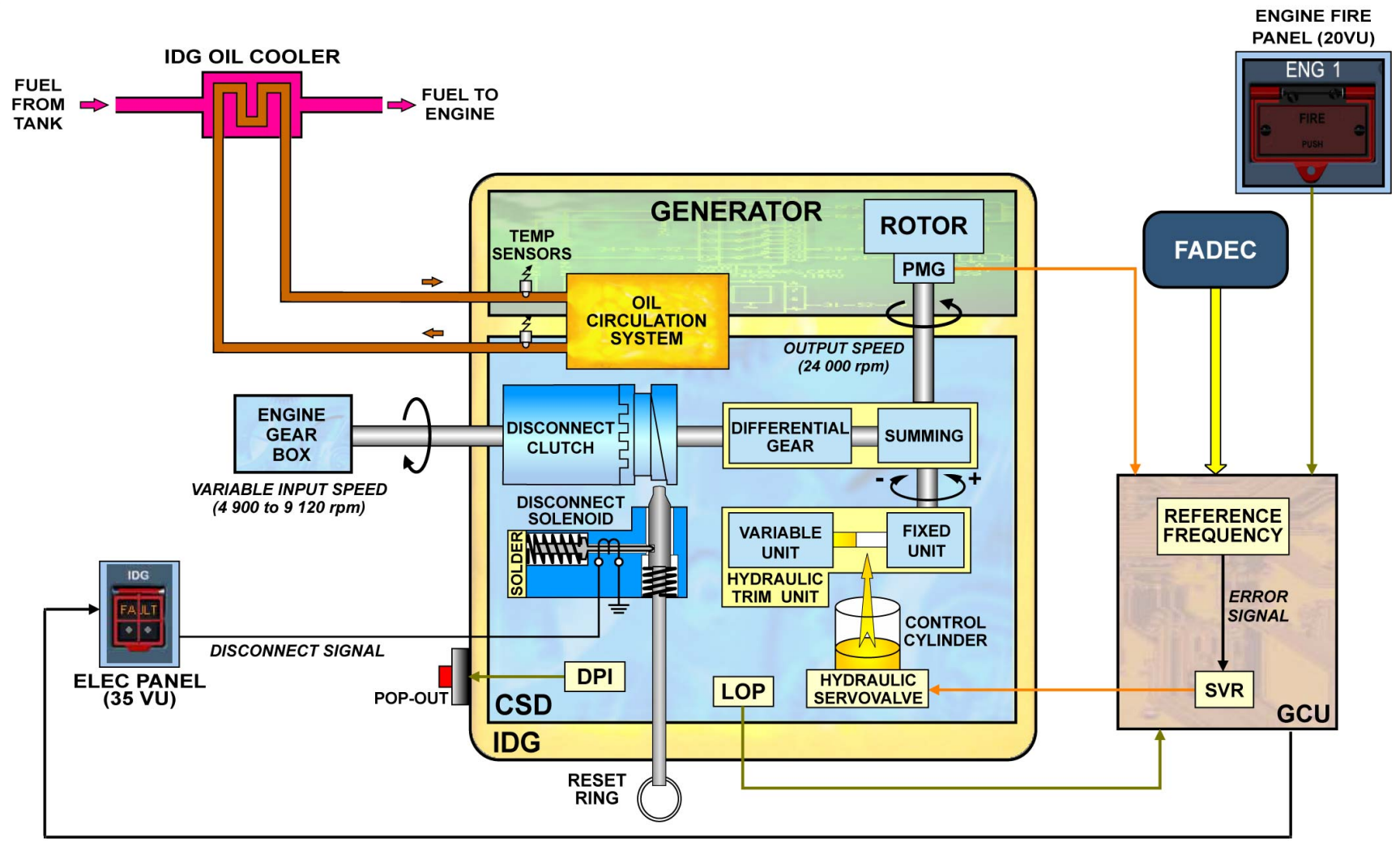
A Low Oil Pressure (LOP) switch located in the IDG charge oil circuit provides a signal to the GCU when IDG charge oil pressure is less than 140 psi. In low oil pressure condition, not caused by underspeed, [the IDG pushbutton FAULT legend comes on amber and an ECAM warning is triggered.

IDG DISCONNECTION

The IDG P/B FAULT legend comes on if the IDG oil pressure is less than 140 psi or if the IDG oil outlet temperature is above 185°C. In both conditions, the IDG must immediately be disconnected! IDG disconnection is achieved by [a solenoid activated clutch. It must be performed, via the IDG switch if the [IDG pushbutton FAULT legend is on. If the temperature reaches 200°C, [a solder fuse melts and automatically releases the disconnect mechanism to open the IDG disconnect clutch.
When the IDG pushbutton is depressed and no underspeed is detected, [a 28V DC signal is sent to the disconnection solenoid which will [open the clutch.
In case of low oil pressure due to underspeed, the FAULT legend remains off. In underspeed condition, it is not possible to disconnect the IDG.
After a thermal disconnection, the IDG must be changed.
IDG reset must be performed on the ground with the engine shutdown, by pulling the [reset ring mounted on the IDG casing.

FIRE SWITCH

In case of engine fire, if the related fire switch is pressed in, a 28V DC signal is sent to the corresponding GCU, which shuts down its IDG. In such a case, the reset of the GCU is not required.



PMG: Permanent Magnet Generator
DPI: Differential Pressure Indicator
LOP: Low Oil Pressure

GENERAL ... FIRE SWITCH

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IDG GENERATOR PART D/O (3)

GENERAL

The AC generator portion of the Integrated Drive Generator (IDG) is a three-phase, brushless, spray oil cooled unit.
The generator rotor consists of an exciter rotor, a diode rectifier assembly, and a two-pole main field rotor. The exciter rotor and main field rotor are mounted on a common shaft supported by a roller bearing set at the drive end and a ball bearing set at the opposite end.
The Permanent Magnet Generator (PMG) rotor is mounted on the outputting gear of the differential assembly.
The main generator stator, exciter stator, PMG stator and generator Current Transformer (CT) are mounted in the IDG housing.

PERMANENT MAGNET GENERATOR (PMG)

The PMG consists of a 16-pole permanent magnet rotor and a three-winding stator. As the engine is running, the PMG rotor induces an AC voltage in the windings of the PMG stator.
At normal operation speed, the output from the PMG is:
- 3 phases
- 1681,3 Hz
- 110 VAC.

The output of the PMG is supplied to the Generator Control Unit (GCU) which uses it for the following functions:
- The GCU transforms and rectifies the voltage via a Transformer Rectifier (TR) to 28V DC for the internal power supply.
- The GCU sends the PMG voltage via the Generator Control Relay (GCR) to the voltage and frequency regulation circuit where it is rectified and applied to the exciter field for voltage regulation.

The PMG frequency is also used to monitor the generator frequency (for the IDG drive control).

GENERATOR EXCITER STAGE

The exciter stage of the generator consists of a three-phase winding rotor which is located on the main generator rotor shaft. The stator windings and a full wave bridge rectifier (rotating diode rectifier) are also located on the rotor shaft. As it rotates, the exciter stage converts a DC field voltage to an AC voltage. The AC voltage is rectified by the rotating diode rectifier and is supplied to the main generator rotor.

MAIN GENERATOR

The main generator consists of a two-pole rotor and a three-phase winding stator. As the rotor rotates, the DC field induces an AC voltage in the stator windings.

CURRENT TRANSFORMER

Current Transformers (CTs) monitor the 3-phase feeder cables, from the Generator to the GLC. The GCUs use the CT outputs for protection functions (differential current, overcurrent, overload). One CT is located inside the IDG and the other is just before the GLC. They are called the 3-Hole Current Transformers.
From the engine pylon to the forward cargo compartment, each feeder cable is split into two, so that there are now two cables per phase (total 6). Another CT, located in the forward cargo compartment, monitors the 6-feeder cables. It is called the 6-Hole Current Transformer. The GCU monitors its current output for open cable protection.

UNDERSPEED

Each GCU receives engine speed data from the Full Authority Digital Engine Control (FADEC) via an ARINC 429 bus. These data are used for the underspeed set point, various other controls and protections and BITE functions.
If these data are not available, the GCU uses the PMG frequency to determine the input speed of the generator.

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With the engine speed below the underspeed set point, the relay 7XT is energized and inhibits an IDG disconnection.

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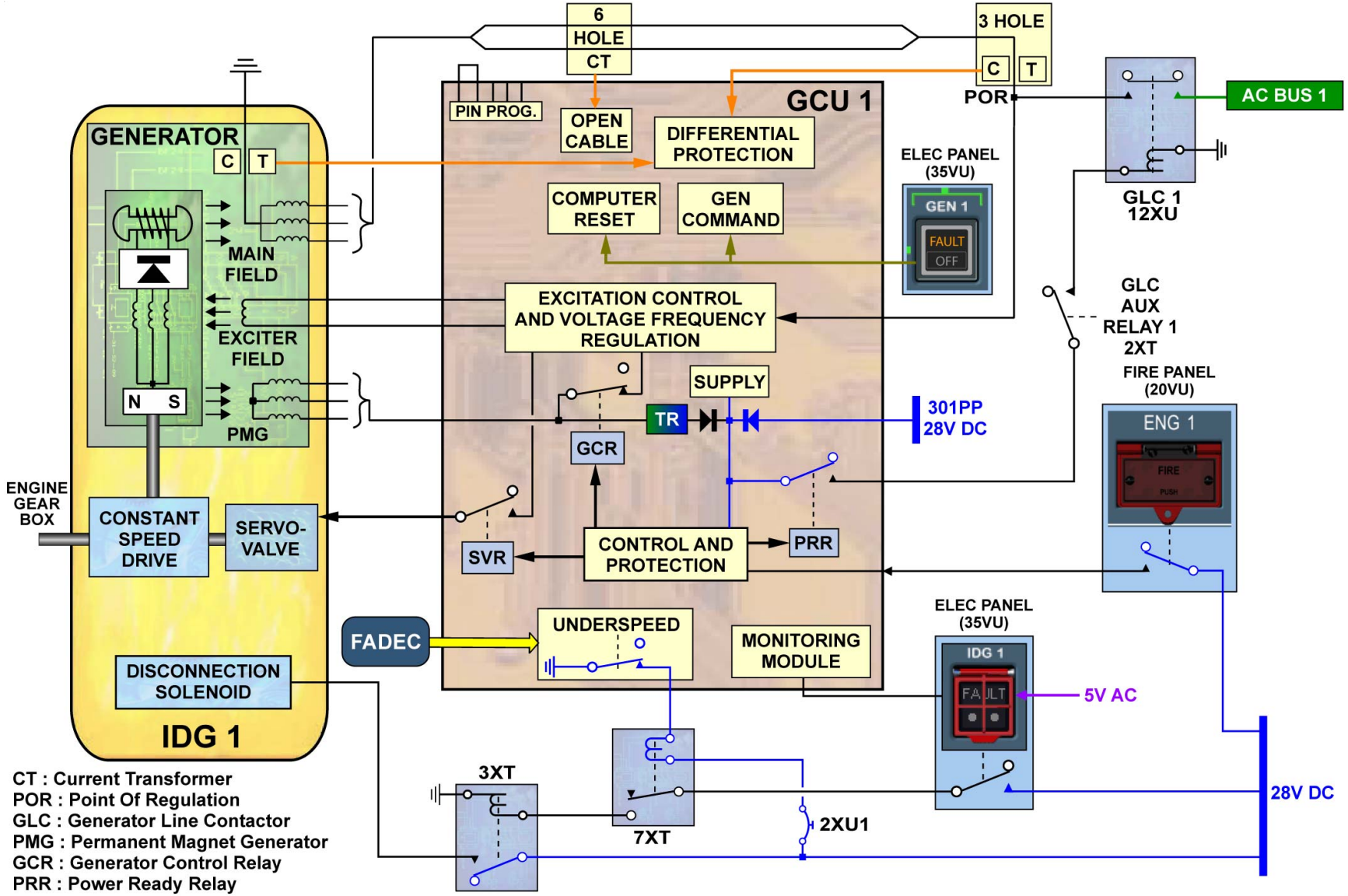

GENERAL - PERMANENT MAGNET GENERATOR (PMG) ... UNDERSPEED

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IDG GENERATOR PART D/O (3)

GENERATOR P/BSW

The GEN P/BSW on the overhead ELEC panel is used to connect or disconnect the generator and to reset the GCU.
When the GEN P/BSW is pressed in (on position) and the generator is not connected, the GEN COMMAND circuit is supplied, enabling the closure of the GCR to excite the generator. If all generator parameters are correct, the Power Ready Relay (PRR) closes and connects power to the Generator Line Contactor (GLC) via the GLC AUX RELAY. The GLC opens or closes to connect 115V AC to the network according to priority rules and the network supply status.

POINT OF REGULATION

The Point Of Regulation (POR) is located between the 3-hole CT and the GLC. It takes in to account the generator feeder impedance (voltage drop of 1 to 2V AC).
The GCU monitors the three-generator phase voltages at the POR for:
- Voltage regulation control,
- Over and undervoltage protection,
- Incorrect Phase Sequence protection.

VOLTAGE REGULATION

The GCU monitors the POR in order to keep the voltage at nominal value (115V AC) at this point.
The principle of operation of the voltage regulator is by modulation of the voltage through the exciter field.
The output from the PMG is connected via the GCR to the excitation and regulation control module, where it is converted into DC voltage and applied to the exciter field.
The voltage frequency regulation module senses the average of the three phases at the POR and compares it against a reference voltage. If a difference exists, the voltage regulator adjusts the exciter field current as needed to keep a constant voltage at the POR.

The FAULT legend comes on amber if during operation any parameter is incorrect. At this time the GCR, PRR and the GLC all open. The SVR will also open if FAULT is frequency related.
Additionally, the FAULT light comes on in the following cases:
- The related engine is shutdown or the generator is not connected
- If the GLC has failed open (STUCK OPEN)

When the GEN P/BSW is released out (off position), the OFF legend appears in white. The GCR opens (if not already open) to de-energize the generator field and the GLC opens.
In addition, the computer reset circuit is supplied to reset the GCU.

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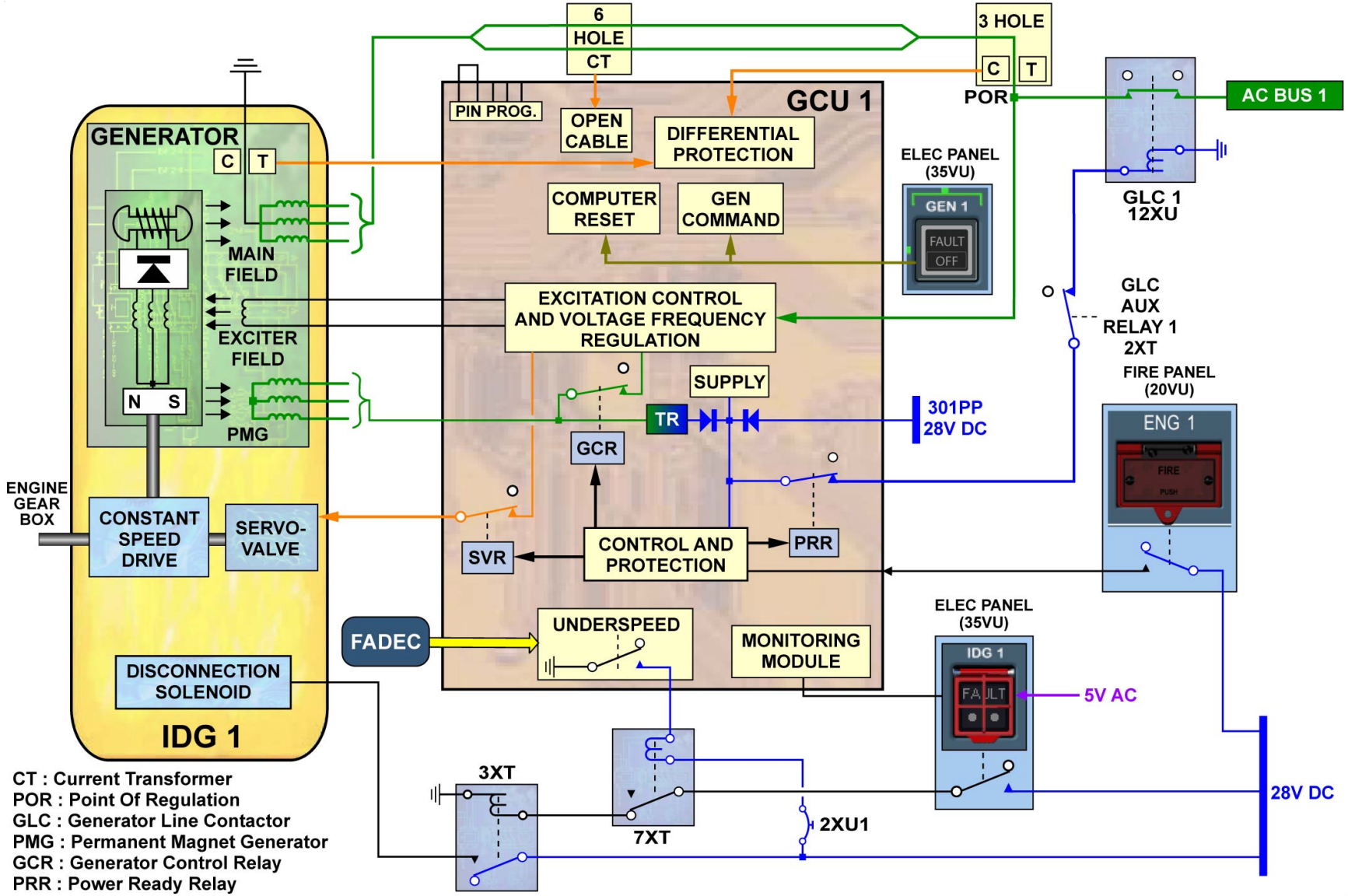
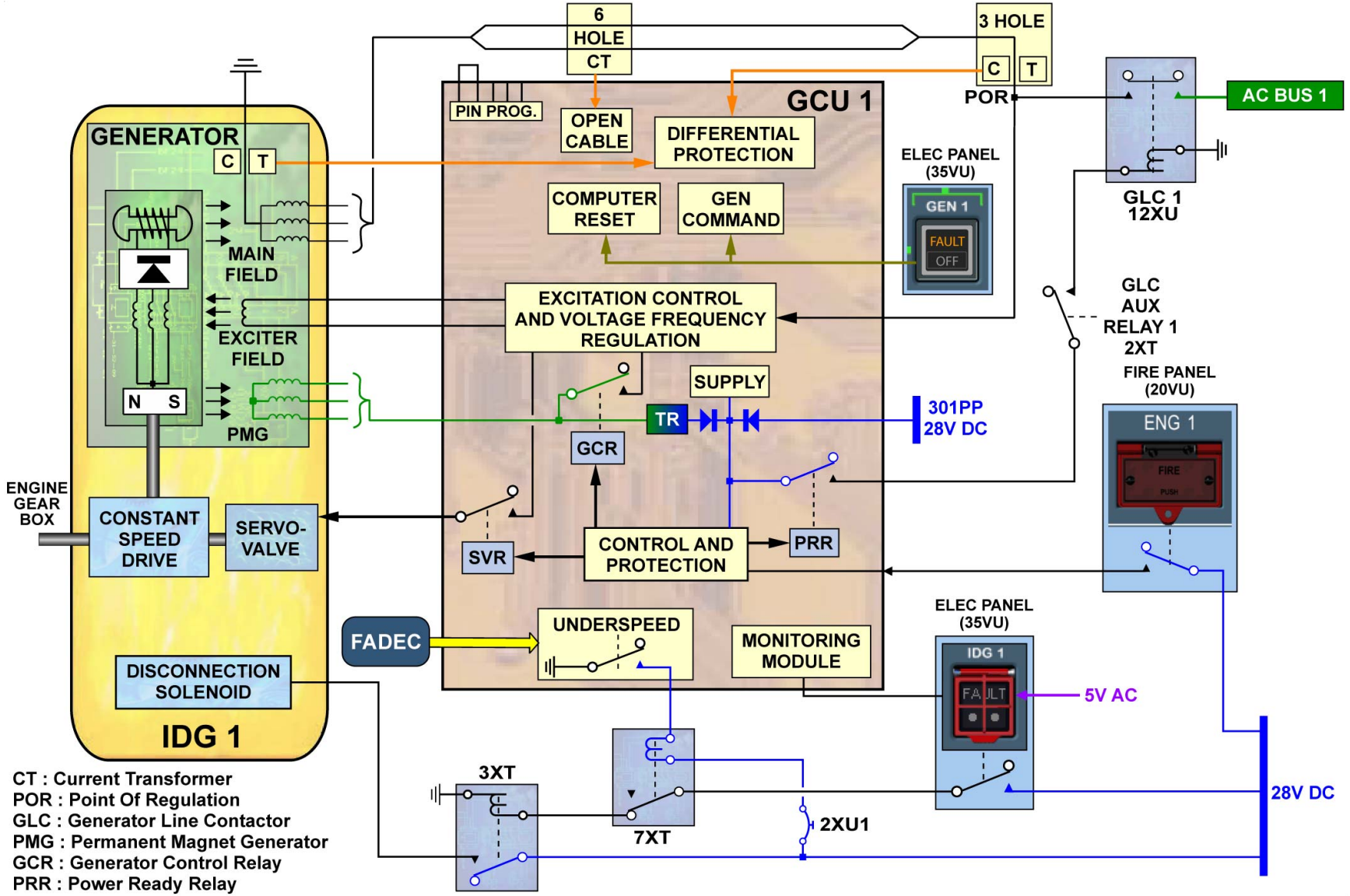
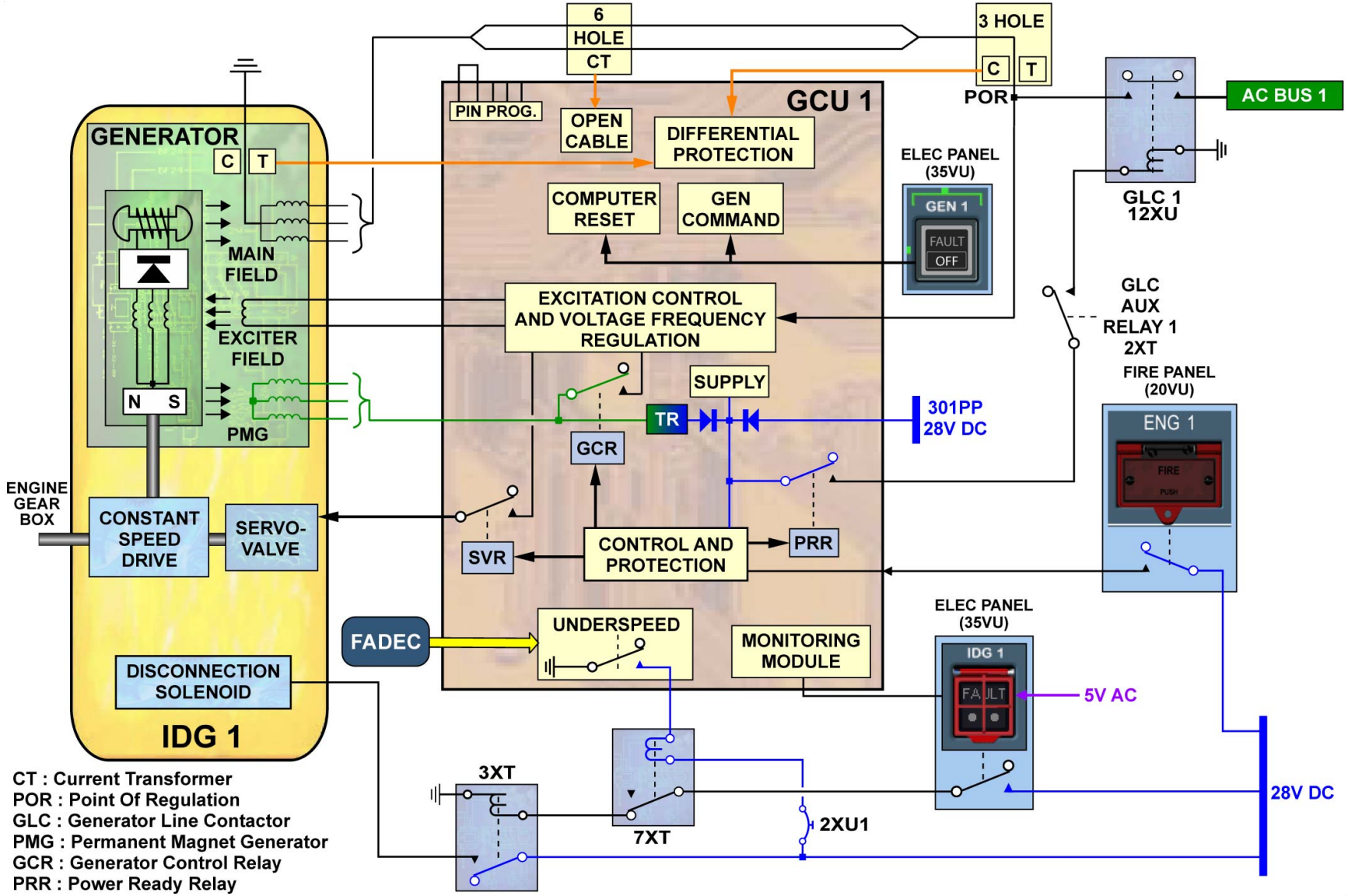


GENERATOR P/BSW - POINT OF REGULATION & VOLTAGE REGULATION



GENERATOR P/BSW - POINT OF REGULATION & VOLTAGE REGULATION



GENERATOR P/BSW - POINT OF REGULATION & VOLTAGE REGULATION

IDG GENERATOR PART D/O (3)

IDG P/BSW

The IDG P/BSW is used for manual disconnection of the IDG from the engine gearbox. If the internal FAULT legend in the IDG P/BSW comes on, the IDG must immediately be disconnected by raising the IDG P/BSW guard and pushing the switch.
When the IDG P/BSW is pushed, the FAULT legend goes out.
With the engine stopped, the IDG cannot be manually disconnected. An underspeed condition, generated by the GCU, inhibits the disconnection.
Notice that for a static test of the IDG disconnect mechanism, the circuit breaker 2XU1 must be pulled to simulate a running engine 1 and no underspeed.

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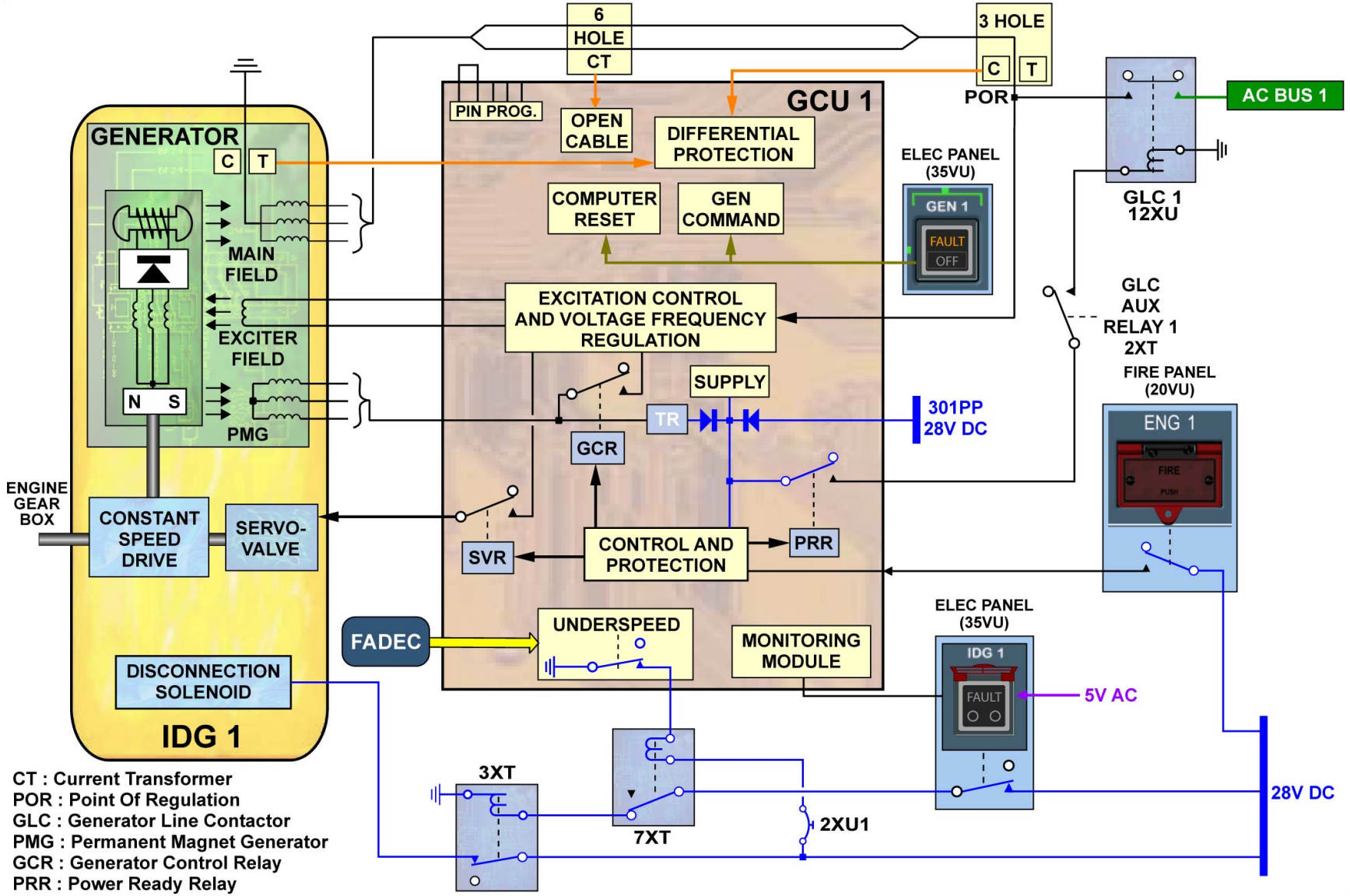
6
HOLE
CT
3 HOLE
C
T
POR
PIN PROG.
GCU 1
OPEN
CABLE
DIFFERENTIAL
PROTECTION
AC BUS 1
GENERATOR
C
T
COMPUTER
RESET
GEN
COMMAND
ELEC PANEL
(35VU)
GEN 1
FAULT
OFF
GLC 1
12XU
MAIN
FIELD
EXCITER
FIELD
N
S
PMG
EXCITATION CONTROL
AND VOLTAGE FREQUENCY
REGULATION
GLC
AUX
RELAY 1
2XT
SUPPLY
FIRE PANEL
(20VU)
TR
301PP
28V DC
ENG 1
FIRE
PUSH
GCR
ENGINE
GEAR
BOX
CONSTANT
SPEED
DRIVE
SERVO-
VALVE
SVR
CONTROL AND
PROTECTION
PRR
ELEC PANEL
(35VU)
FADEC
UNDERSPEED
MONITORING
MODULE
IDG 1
FAULT
5V AC
DISCONNECTION
SOLENOID
IDG 1
3XT
7XT
2XU1
28V DC
CT : Current Transformer
POR : Point Of Regulation
GLC : Generator Line Contactor
PMG : Permanent Magnet Generator
GCR : Generator Control Relay
PRR : Power Ready Relay

IDG P/BSW

AC MAIN GENERATION D/O (3)

IDG

Two identical Integrated Drive Generators (IDGs) are used to supply the main AC network.
Each IDG is a two-pole high-speed (24 000 rpm) brushless spray oil cooled unit.
It comprises the drive part and the generator part in a common housing.
The generator part has a Permanent Magnet Generator (PMG), an exciter generator with rotating diodes and the main generator.
Each IDG is controlled and monitored by its own Generator Control Unit (GCU).

GCU

Each Generator Control Unit (GCU) is supplied by the PMG from its related IDG and, as a back-up, through the battery bus 301PP. The related engine under speed information is given by the Full Authority Digital Engine Control (FADEC).
The main functions of the GCU are:
- control of the field excitation via the Generator Control Relay (GCR),
- voltage regulation via the Excitation Control and Regulation module,
- speed regulation through the ServoValve Relay (SVR),
- control of the Generator Line Contactor (GLC) via the Power Ready Relay (PRR), the Bus Tie Contactor (BTC) and the AUX RELAY 1,
- control and protection of the IDG and the network.

GENERATOR P/BSW

The generator P/BSW is used to connect or disconnect the generator output to or from the bus bar, and to reset the GCU.
The FAULT legend comes on when the P/BSW is pressed in and the related engine is shutdown or during operation if any parameter is not correct. The fault information is sent via the SDACs to the ECAM.
The OFF legend comes on when the P/BSW is released out. After a fault detection (tripping of the generator), cycling the GEN 1(2) switch OFF/ON resets the GCU.

GEN 1 LINE P/BSW

In SMOKE configuration (red smoke light on) an activation of this P/BSW opens the GLC but the generator stays energized to supply directly the fuel pumps 1 LH and 1 RH side (the OFF legend indicates, the P/BSW position).
Notice that during the AVIONICS SMOKE procedure (GEN 1 LINE P/BSW OFF), the related generator FAULT light remains off.

GLC/BTC CONTROL AND MONITORING

The GLC and the BTC are under control of the related GCU and the Bus Tie Logic.
If all parameters are correct, the GLC connects the generator to its own bus bar.
The BTC connects the generator to the transfer line or another power source to the bus bar (with generator off) depending on the priority logic.

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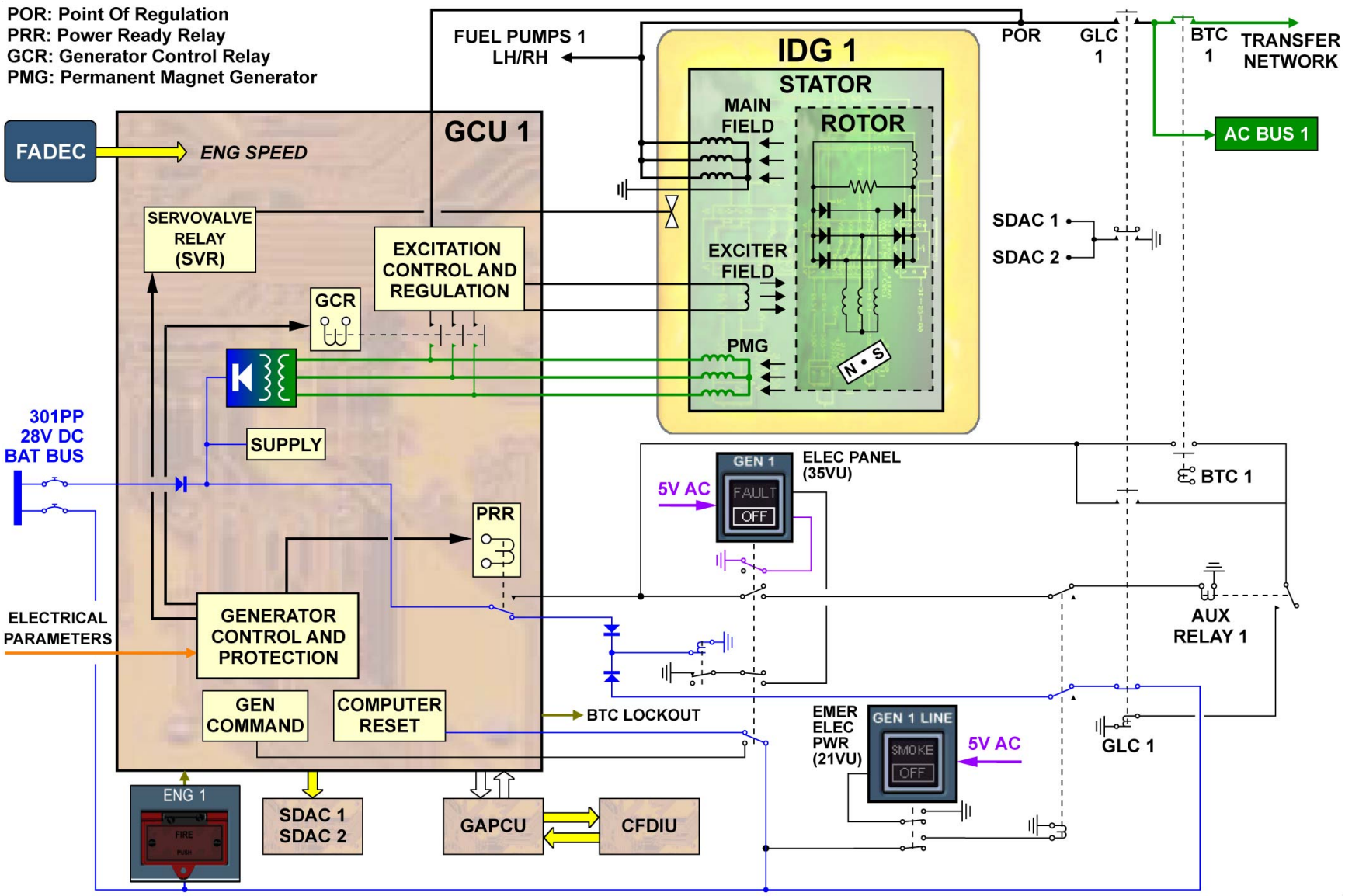

IDG ... GLC/BTC CONTROL AND MONITORING

AC MAIN GENERATION D/O (3)

INTERFACES

The GCU interfaces with:
- The engine fire pushbutton switch. When pushed in, the generator is de-energized.
- Both SDACs for the ECAM monitoring.
- The CFDIU through the GAPCU (BITE type 1 data to CFDIU)
- The FADEC which gives the engine speed information.

OPERATION

In normal operation all internal relays of the GCU are energized. Through the energized contacts of the PRR, the de-energized contact of the BTC and the energized contacts of the AUX relay, the Generator Line Contactor (GLC) is then energized. The de-energized state of the BTC makes sure that there is no supply to the BUS before the Generator takes over the supply.

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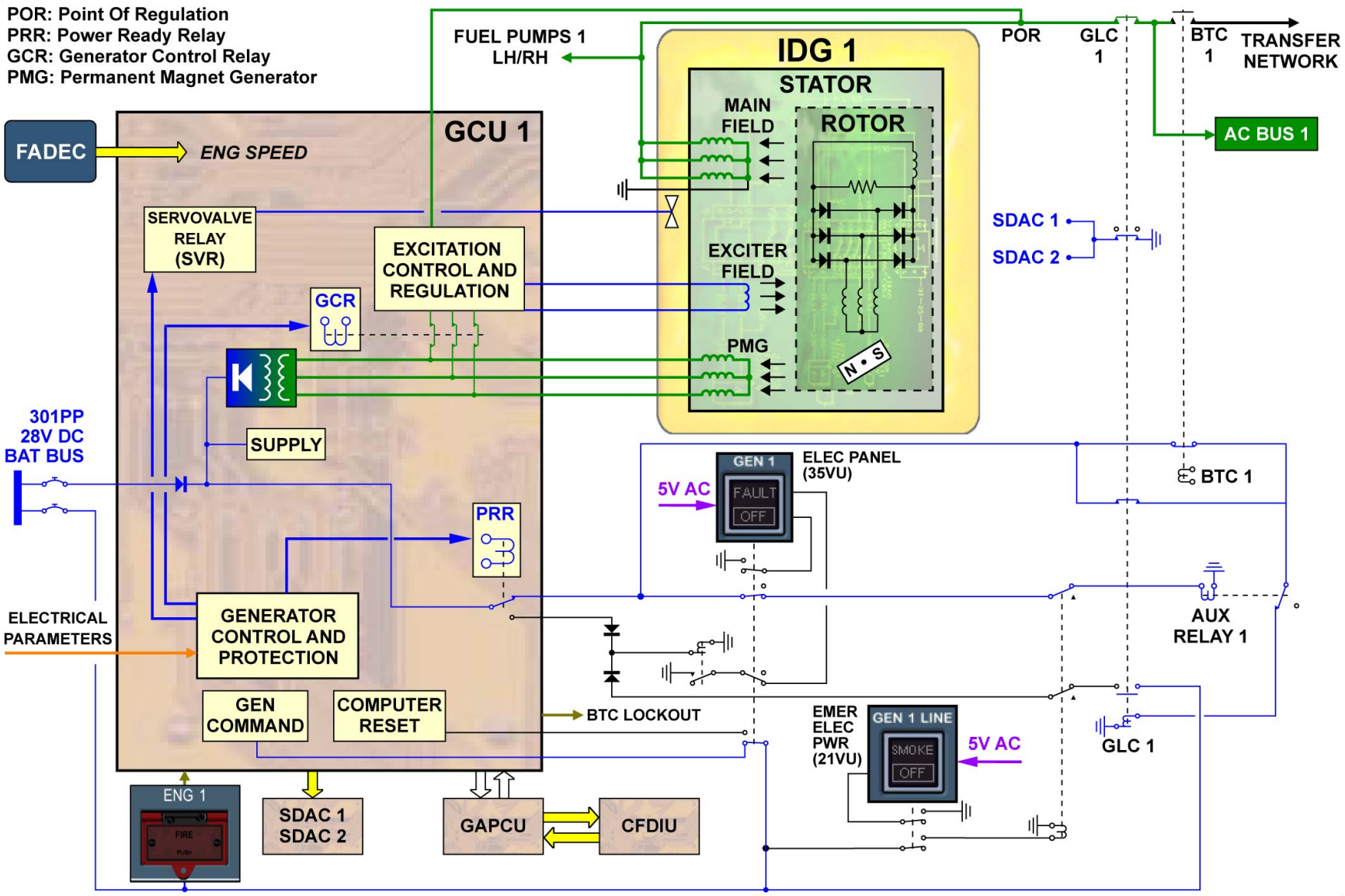

INTERFACES & OPERATION

AC MAIN GENERATION D/O (3)

OPERATION (continued)

GEN FAULT

If the GEN pushbutton is in the "on" position and the PRR of the GCU is not energized, the fault light on the GEN pushbutton comes on by a ground due to the pushbutton position. The PRR is de-energized, among other reasons, when the voltage and frequency are not in tolerance. If the engine is not started, there is no regulation possible for both voltage and frequency. Therefore, the FAULT lighting is normal when the engine is not running.

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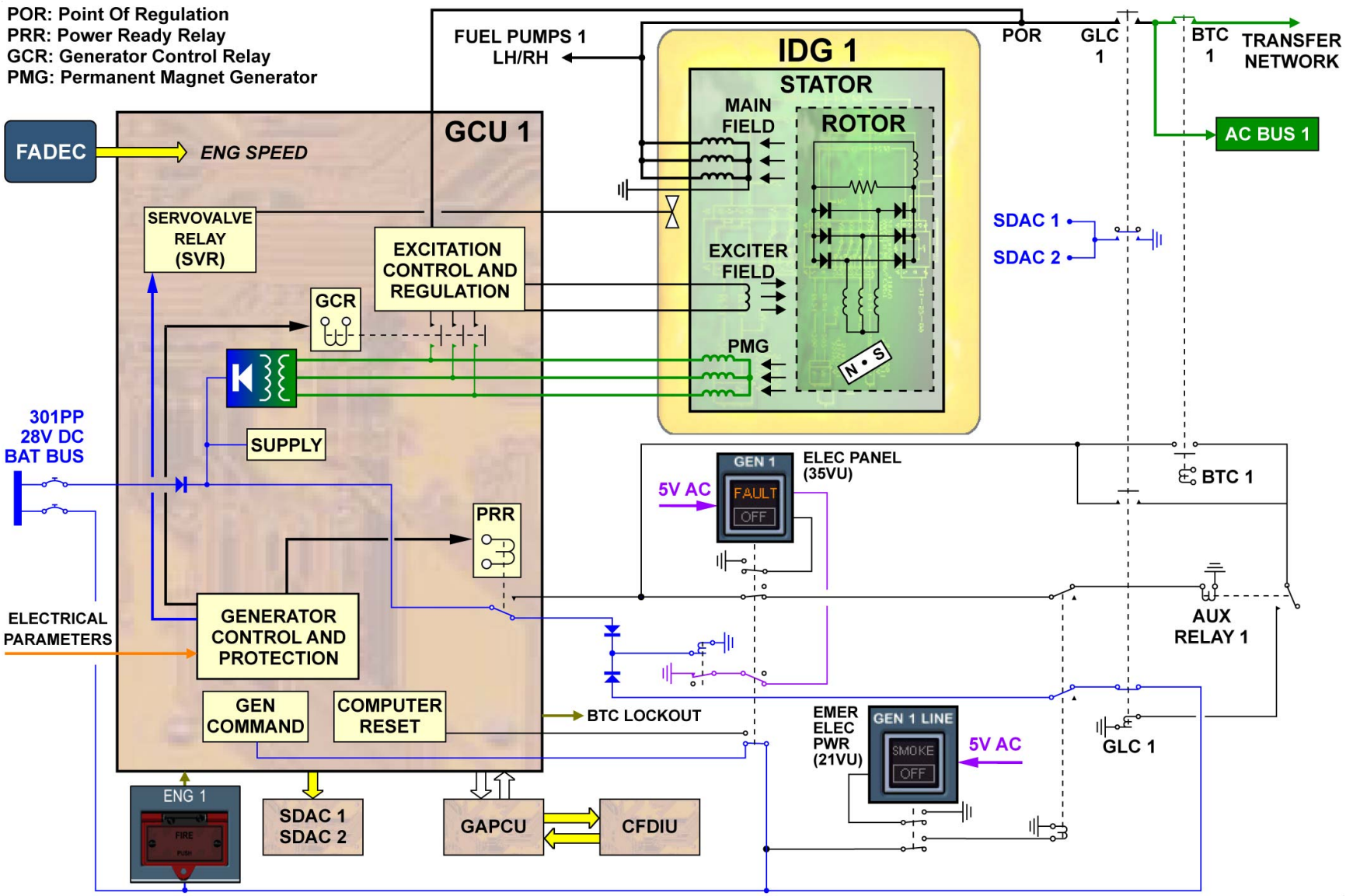

OPERATION - GEN FAULT

AC MAIN GENERATION D/O (3)

OPERATION (continued)

GEN 1 LINE OFF

If the GEN 1 LINE pushbutton is released, the OFF legend comes on and the supply voltage to the AUX relay is interrupted. Since the contacts of the AUX relay now are in the de-energized position, the supply voltage to the GLC relay is interrupted. However, the Generator is still regulated and functioning normally to allow direct supply from the Generator to the electrically driven fuel pumps in both wings.

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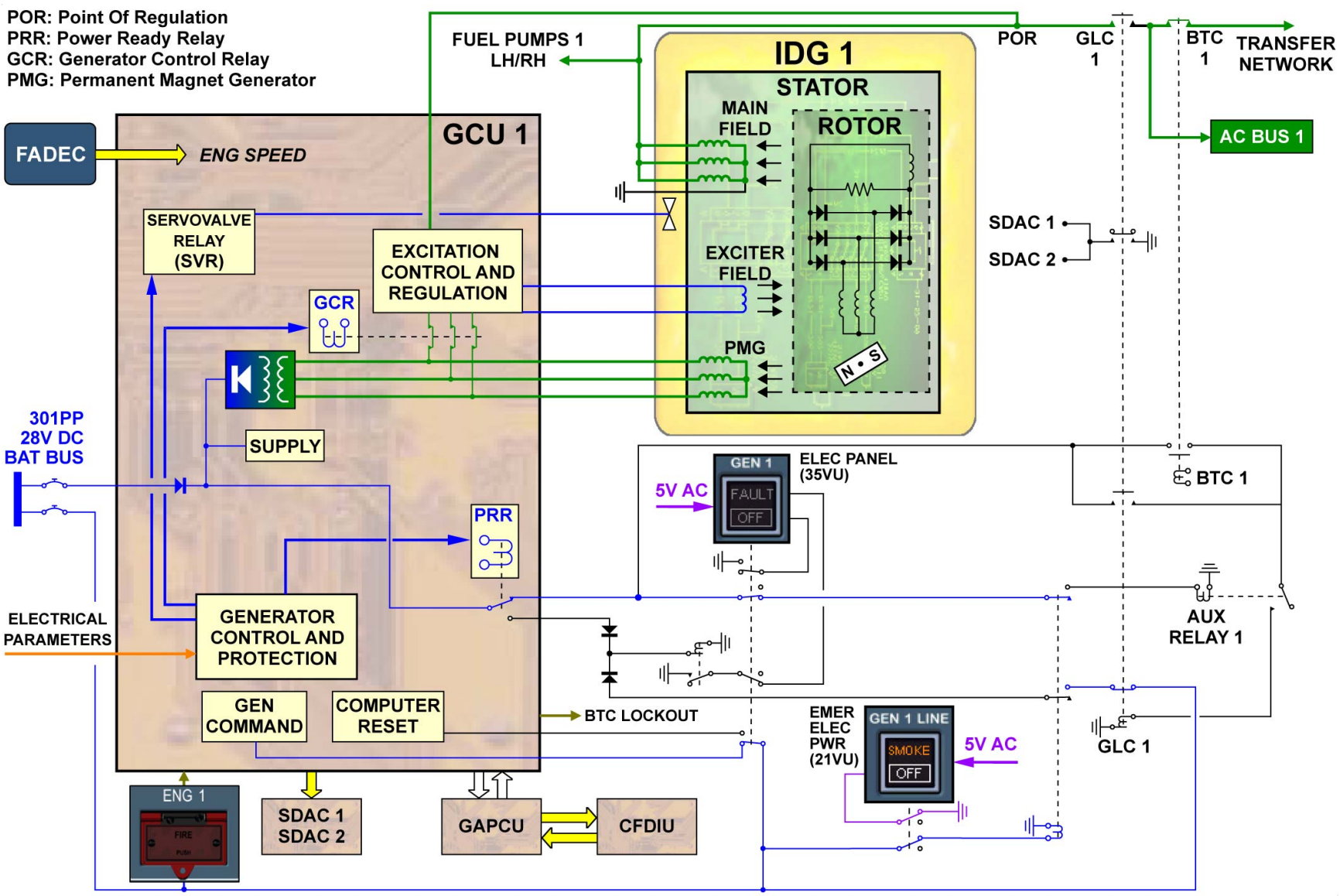

OPERATION - GEN 1 LINE OFF

GCU D/O (3)

GENERAL

The Generator Control Unit (GCU) 1 and 2 are identical and interchangeable. Pin programming provides the GCU with the following information:
- the aircraft type,
- the GCU position,
- the current limit for voltage regulation,
- the load limit.

The main functions of the GCU are:
- regulation of the generator voltage,
- regulation of the generator frequency,
- regulation of the generator speed (ServoValve (SV) control),
- control and protection of the network and the generator,
- interface with System Data Acquisition Concentrator (SDACs) for the ECAM,
- interface with Full Authority Digital Engine Control (FADEC) for engine speed,
- interface with Centralized Fault Display System (CFDS) via the Ground and Auxiliary Power Control Unit (GAPCU).

VOLTAGE REGULATION

The voltage regulation is achieved by regulating the current through the exciter field. The voltage is kept at a nominal value (115V AC) at the Point Of Regulation (POR). The POR is located at the end of the generator feeder upstream of the Generator Line Contactor (GLC). The output from the Permanent Magnet Generator (PMG) is connected via the Generator Control Relay (GCR) to the excitation and regulation control module for frequency monitoring use.

FREQUENCY REGULATION

The Integrated Drive Generator (IDG) frequency is regulated by a servovalve in the IDG and the servovalve control circuit in the GCU (via the SV relay).
The PMG frequency is compared with a GCU internal reference frequency. The difference generates a control current to drive the servovalve to produce the right output frequency.

CONTROL AND PROTECTION

The GCU control and protection functions are mainly performed by 3 internal relays:
- the GCR controls the generator excitation,
- the Power Ready Relay (PRR) controls the GLC,
- the SV relay controls the IDG speed.

If a protection function is triggered, the GCR, the PRR and, in some cases the SV relay, are de-energized.

UNDERSPEED

Engine speed information provided by FADEC is used to sense the IDG input speed. When engine speed falls below the underspeed threshold the PRR trips and the excitation is biased off due to underfrequency. In case of an absent FADEC speed signal to the GCU, a back-up signal is provided by the engine master switch to inform the GCU logic that the engine will shut down.
Note: in case of detected underspeed (e.g. engine shut down) no reset action via the GEN P/BSW is required.

OVERVOLTAGE

The GCU performs an overvoltage protection function. If the highest individual phase at POR reaches 130 ± 1.5 volts, the PRR and the GCR are tripped.
The higher the voltage, the faster the relays trip.

OVERFREQUENCY

The GCU performs an overfrequency protection function. If the frequency is above 435 ± 1Hz, for at least 4 seconds, the GCU trips the PRR and the GCR. If the frequency is above 452 Hz, for at least 160 milliseconds, the GCU trips the PRR, the GCR and also the SV relay.

OVERLOAD / OVERCURRENT

The IDG Current Transformers (CTs) provide current sensing information to the GCU. This information is used to determine generator load for overload, overcurrent, phase imbalance (delta) and also Differential Current Protection. In case of overload, the GCU sends signals to the SDAC for an ECAM message and to the FAULT light on the GALY & CAB P/BSW.
If an IDG fails, the Bus Tie Contactors (BTCs) close and some galleys loads are automatically shed.
GCUs monitor BTC status and determine if overcurrent protection (BTC lockout) should be inhibited. If the galleys are not automatically shed the BTC lockout is inhibited, to allow the GALY & CAB P/BSW to be selected OFF.

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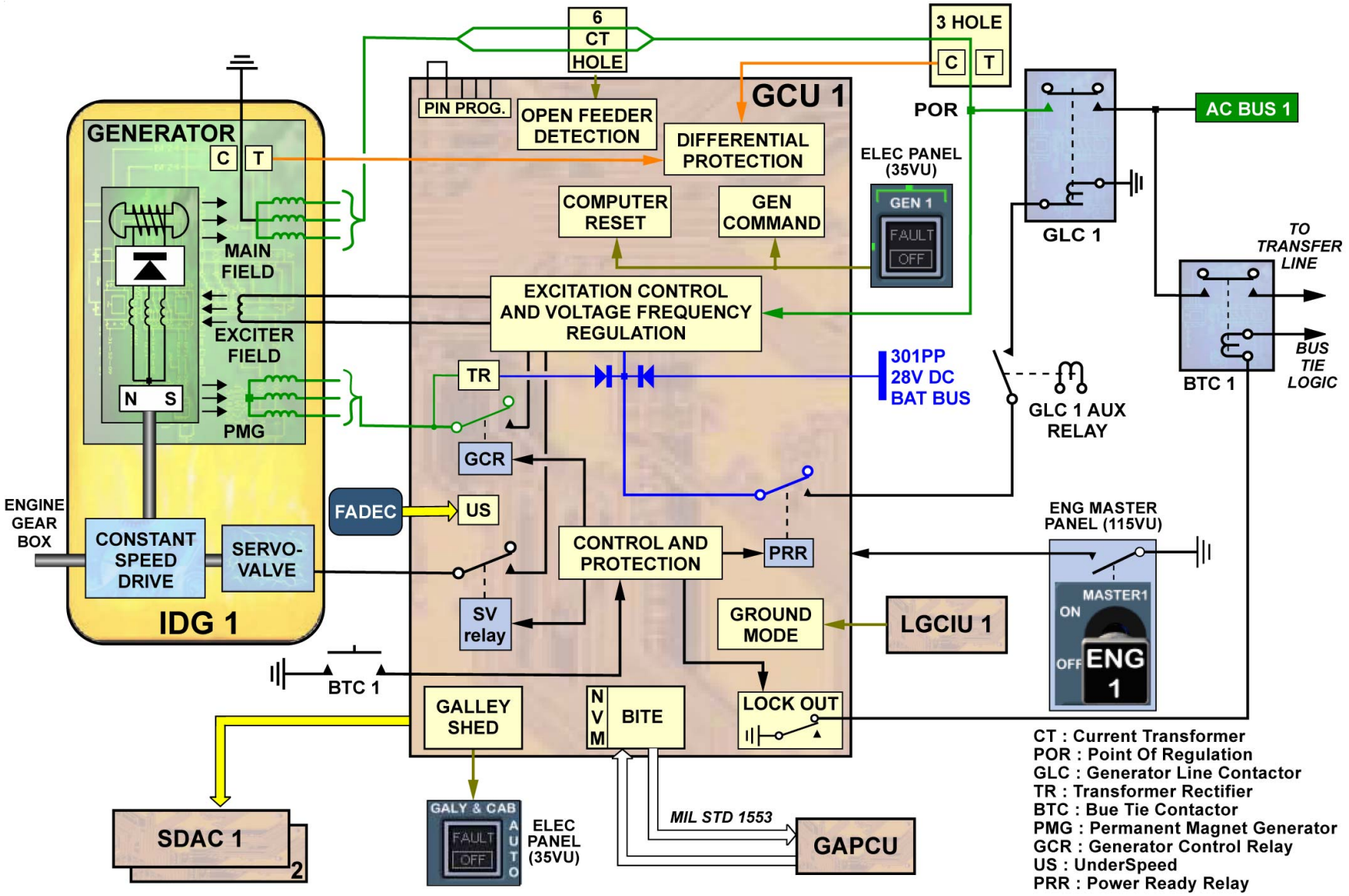

GENERAL ... CONTROL AND PROTECTION

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GCU D/O (3)

ENGINE FIRE AND OPEN FEEDER CABLE PROTECTION

The feeder cables are duplicated from the engine pylon to the forward cargo compartment. A 6 hole CT monitors each cable. If an open cable is detected, or if the ENG FIRE P/BSW is released out, the GCU trips the GCR and the PRR. The GLC opens after the PRR trips.

DIFFERENTIAL CURRENT PROTECTION

The Differential Protection is based on the comparison of each phase of the Line 3-hole CT and the CTs in the IDG. If a differential current flow is above 50 ± 10A for at least 60 milliseconds, the PRR and GCR are tripped.
Note: the Differential Protection circuit reset is done via the GEN P/BSW, but it is limited to two attempts. After correcting the fault a cold reset must be performed.

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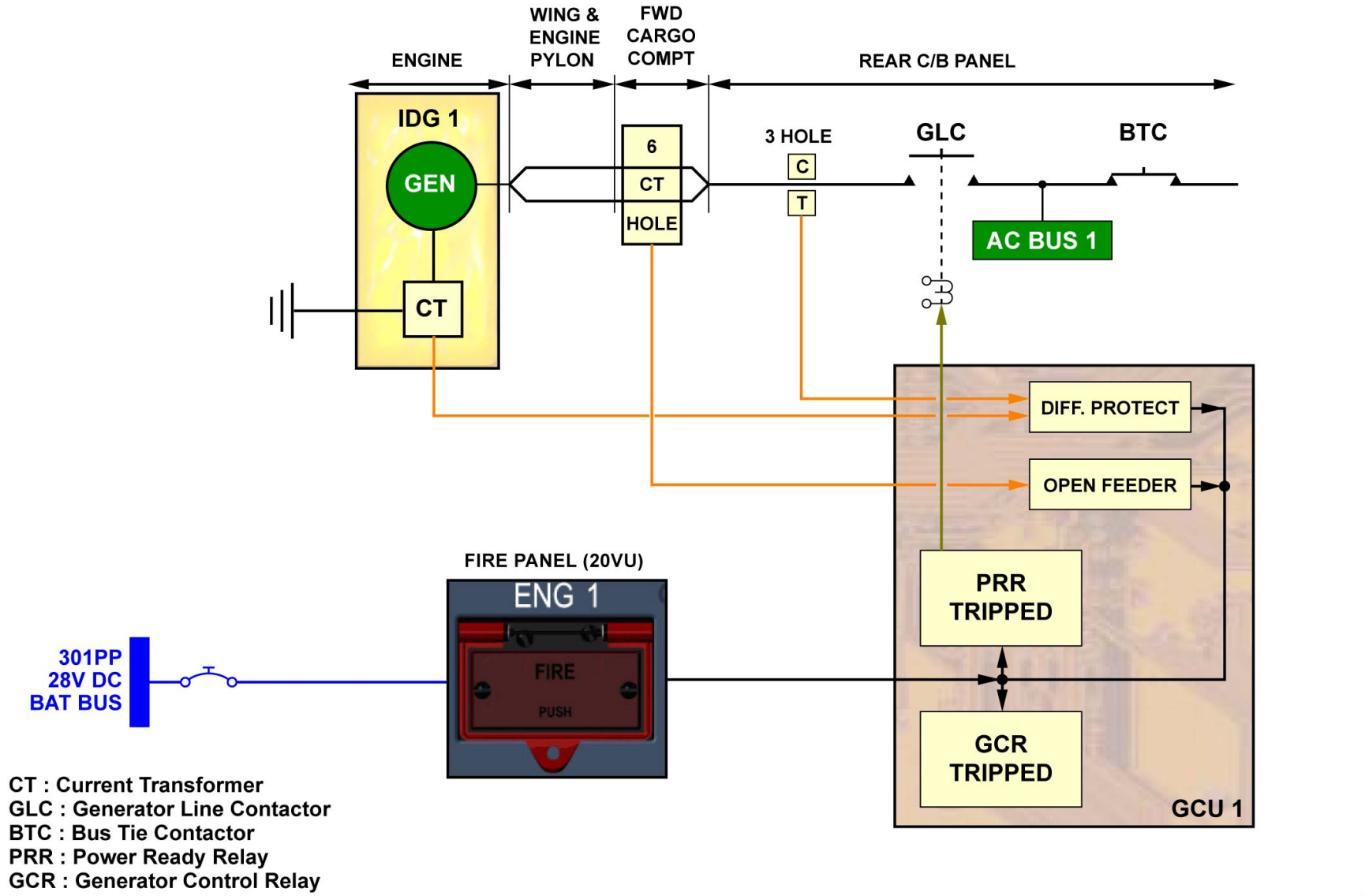

ENGINE FIRE AND OPEN FEEDER CABLE PROTECTION & DIFFERENTIAL CURRENT PROTECTION

GCU D/O (3)

PROTECTION FUNCTION SUMMARY

The Generator Control P/BSW has ON and OFF/RESET functions. Switch all power off and then on again to reset the fault logic; this is called a cold reset. Most fault protections allow two reset attempts and then the reset function is inhibited.

BITE

The GCU is a type 1 computer. Its BITE detects and isolates active and passive failures.
The BITE consists of two sections:
- Operational BITE,
- Maintenance BITE.

After generator tripping, the operational BITE identifies the protection, analyses the conditions and determines the fault origin.
The maintenance BITE completes the operational BITE and performs a self-test of the GCU to provide an indication of system integrity. Faults are kept in the Non Volatile Memory (NVM). The GCU BITE communicates with the CFDS via the GAPCU (type 1 system).

INTERFACE

Each GCU is interfaced to both SDACs to transmit system failure or caution data to the ECAM. The Landing Gear Control and Interface unit (LGCIU) 1 provides ground/flight information to the GCU (BITE).

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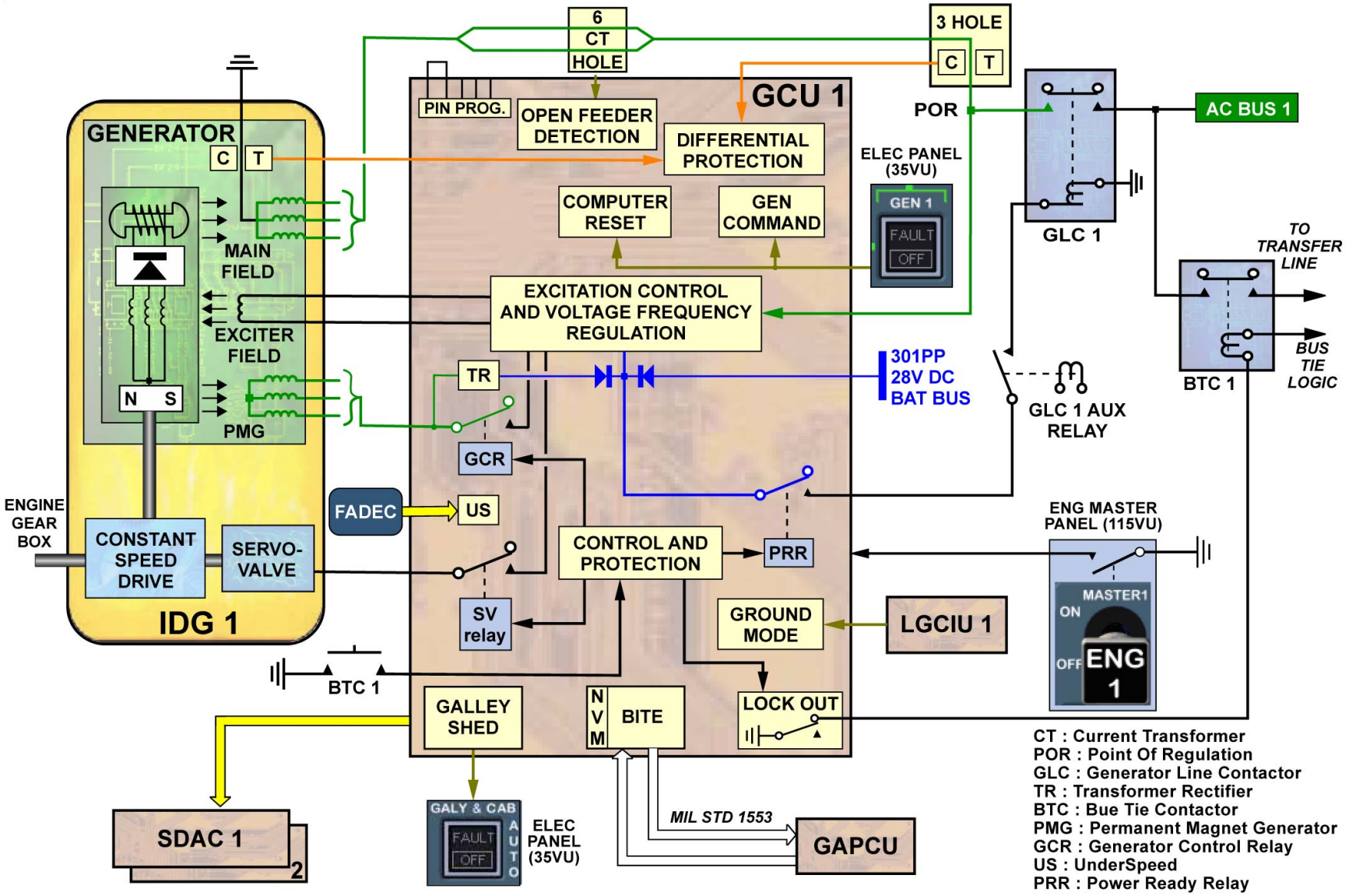

PROTECTION FUNCTION SUMMARY ... INTERFACE

AC AUXILIARY GENERATION GENERAL DESCRIPTION (2)

APU GENERATOR

The APU generator is not interchangeable with the Integrated Drive Generators (IDGs).
It is driven at a constant speed by the APU and can be connected to the electrical network.
It can supply the entire electrical network if no other power sources are available.

APU GENERATOR CONTROL

The APU Generator control module is part of the Ground and Auxiliary Power Control Unit (GAPCU).
The main functions of the module are:
- voltage regulation,
- frequency monitoring,
- APU Generator Line Contactor (GLC) control in accordance with the bus tie logic,
- control and Protection,
- [Interface with System Data Acquisition Concentrators (SDACs),
- Built-In Test Equipment (BITE) function. The BITE messages are sent to the CFDIU.

CONTROL, INDICATION AND DISTRIBUTION

The APU generator is controlled by a P/BSW located on the overhead ELEC panel and has two lights: white OFF and amber FAULT.
The APU GEN is connected to the network via the APU GLC and the Bus Tie Contactors (BTCs).

APU GEN OIL TEMPERATURE SENSOR

A temperature sensor is located on the APU generator oil outlet port.
A high oil temperature leads to an immediate automatic shut down of the APU via the Electronic Control Box (ECB).

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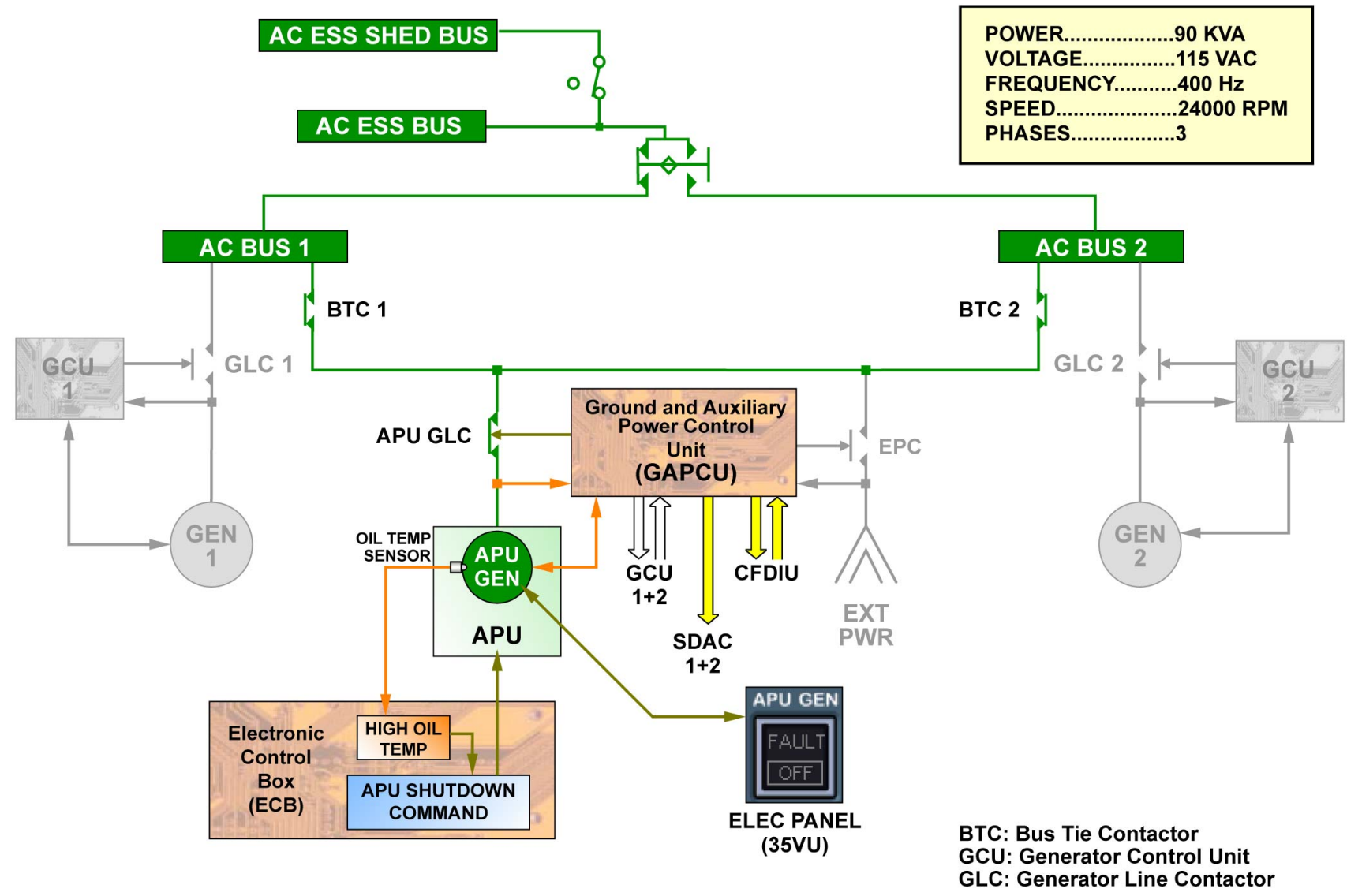

APU GENERATOR ... APU GEN OIL TEMPERATURE SENSOR

AC AUXILIARY GENERATION D/O (3)

APU GENERATOR

The APU generator can supply all or part of the normal network, depending on the priority logic given by the bus tie logic. The APU generator is a two-pole high speed (24 000 rpm) brushless spray oil cooled generator. Speed regulation is made by the APU engine without a Constant Speed Drive (CSD); it is not interchangeable with the Integrated Drive Generators (IDGs).The APU generator is cooled and lubricated by the APU oil.
An oil temperature bulb is installed on the APU generator oil outlet part. The bulb is directly connected to the APU [Electronic Control Box (ECB). In case of oil temperature above 185°C, the ECB commands an immediate [shutdown of the APU.

APU GEN CONTROL MODULE (GAPCU)

The APU Generator Control Module is part of the Ground and Auxiliary Power Control Unit (GAPCU). The GAPCU controls both the APU generator and the EXT PWR.
The power for the GAPCU is supplied by:
- the APU Permanent Magnet Generator (PMG),
- the EXT PWR,
- the BATtery BUS as a back-up supply.

The control module main functions are:
- control of the field excitation through the Generator Control Relay (GCR),
- voltage regulation,
- control of the APU Generator Line Contactor (GLC) through the Power Ready Relay (PRR) in conjunction with the bus tie logic,
- control and protection of the APU generator and the network.

The GAPCU has an interface with the SDAC and to the CFDIU.
APU ECB carries out the speed regulation. At 95% rpm, the ECB sends an APU ready signal to the GAPCU.

APU GEN CONTROL AND MONITORING

The APU generator switch is used to connect or disconnect the APU generator and to reset the GAPCU.
- The FAULT legend only comes on if the switch is pressed in, the APU is running (>95%), and one parameter is not correct.
- The OFF legend comes on when the switch is released out.

After a fault detection (tripping of the generator), the GAPCU must be reset by setting the switch to OFF and back to ON.
The APU Generator Line Contactor (GLC) is under control of the GAPCU and the bus tie logic. If all generator parameters are correct, the AGLC connects the generator to [the transfer line. The connection to the busbars depends on the priority logic and the network supply status (BTCs and GLCs).

TRANSFER CIRCUIT

The transfer circuit has a [transfer line and the two [BTCs. This circuit lets the power sources (GEN 1, 2, APU, External Power) supply all or half of the network according to the priority and the bus tie logic.
The bus tie logic gives information about the network supply status. This information is used for:
- Non parallel operation,
- Supply priority,
- Transfer circuit control.

APU GEN FEEDER CABLES

The feeder cables are routed through the cabin ceiling to the rear C/B panel in the cockpit where they are sent through a [3-hole current transformer before connection to the APU GLC. [The Current Transformer (CT) gives differential current protection.

OPERATION

The purpose of this paragraph is to describe the operation of the APU with or without GEN1.

ONLY APU RUNNING

With the APU running and the APU GEN pushbutton in the ON position, the connection to the transfer network is only possible if one or both of the IDG Generators are offline and the External electrical power not connected. Two sets of contacts from the de-energized EPC AUX relay and the contacts from the de-energized EPC make sure that the APU GLC voltage supply is interrupted even if the PRR of the APU Generator GCU is energized.
If the EPC AUX and the EPC are de-energized (no ground electrical power) the contacts of the IDG's GLCs and the BTCs will then determine if the APU GLC will be energized. If the IDG's GLCs are de-energized and the BTCs are energized, the APU GLC is then energized and the APU generator supplies the transfer network.

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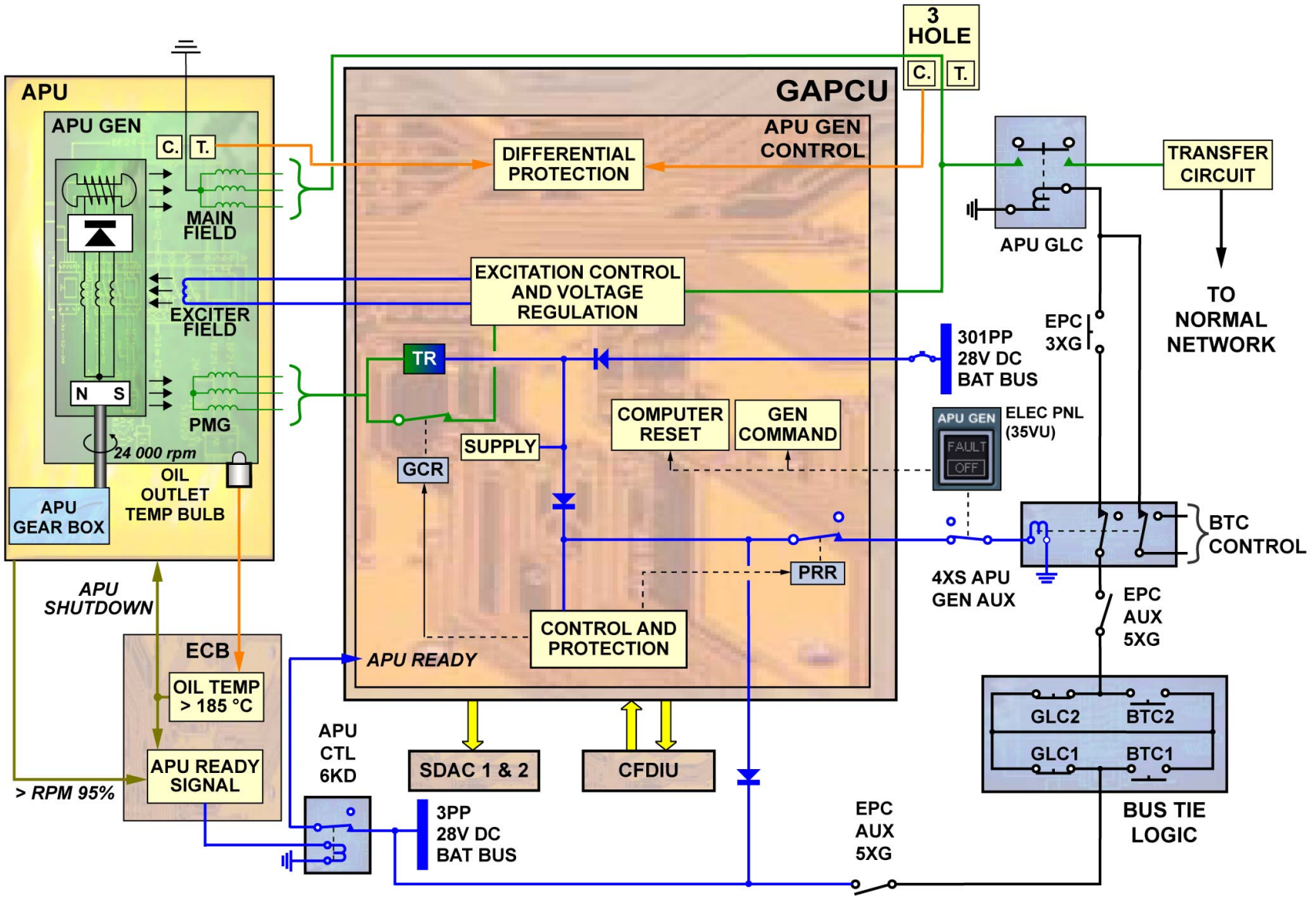
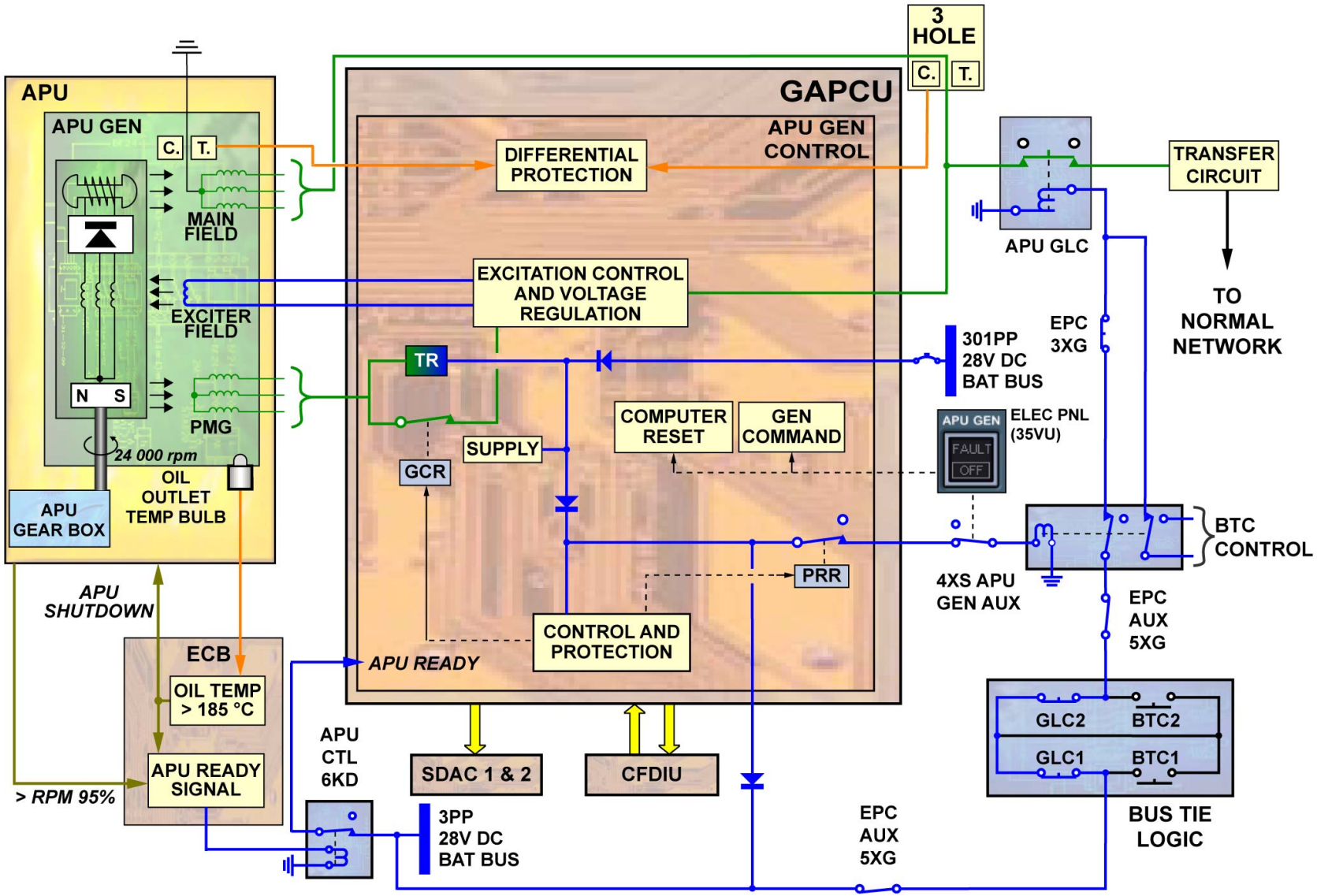


APU GENERATOR ... OPERATION



APU GENERATOR ... OPERATION

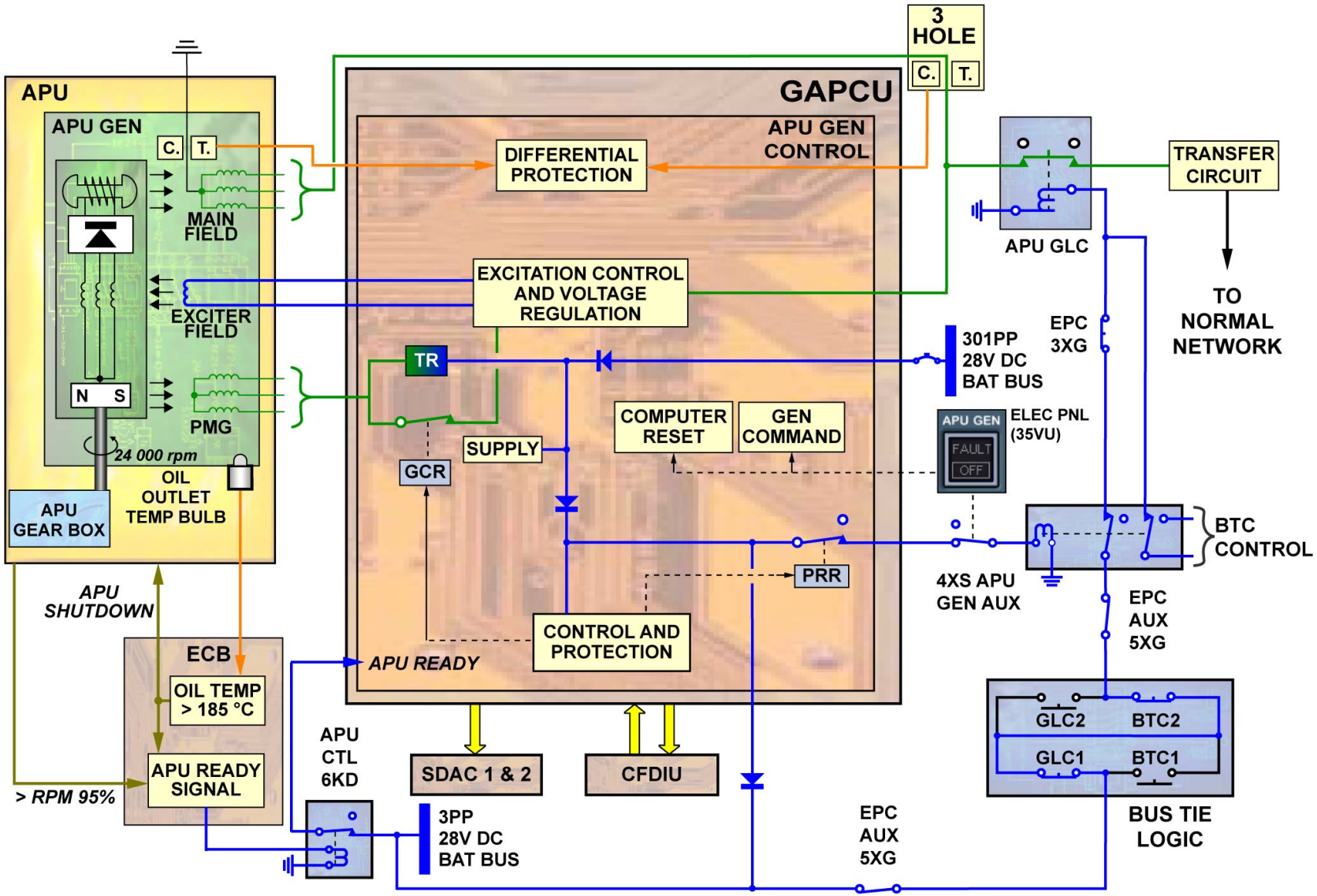
AC AUXILIARY GENERATION D/O (3)

OPERATION (continued)

APU AND GEN2 RUNNING

If the EPC AUX and the EPC are de-energized (no ground electrical power) and GLC 1 and BTC 2 are de-energized, the APU GLC is energized. The APU Generator now supplies AC Bus 1 through the transfer network, but not AC Bus 2.

UGB13131 - U7ST0M0 - UM24D7000000001



OPERATION - APU AND GEN2 RUNNING

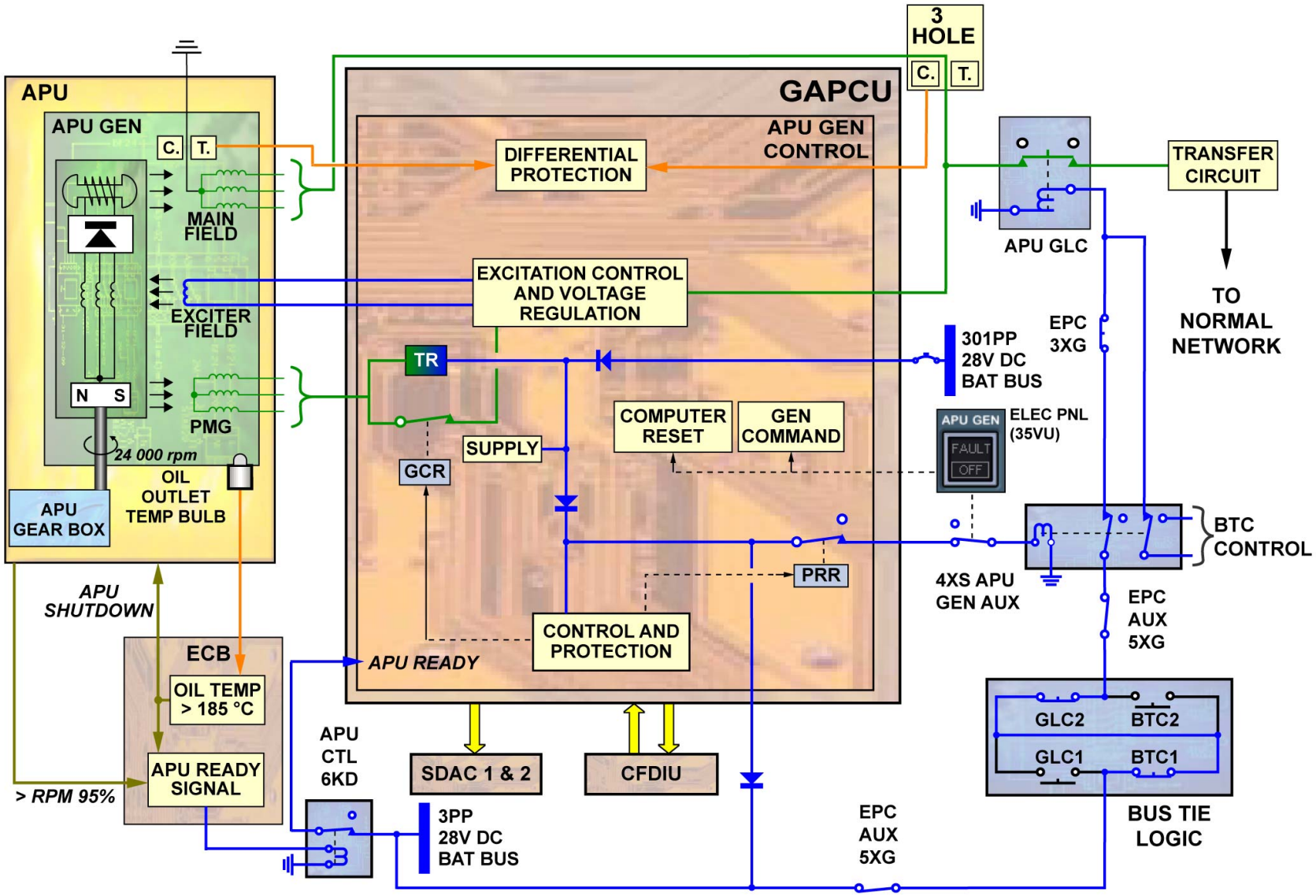
AC AUXILIARY GENERATION D/O (3)

OPERATION (continued)

APU AND GEN1 RUNNING

If the EPC AUX and the EPC are de-energized (no ground electrical power) and GLC 2 and BTC 1 are de-energized, the APU GLC is energized. The APU Generator now supplies AC Bus 2 through the transfer network, but not AC Bus 1.

UGB13131 - U7ST0M0 - UM24D7000000001



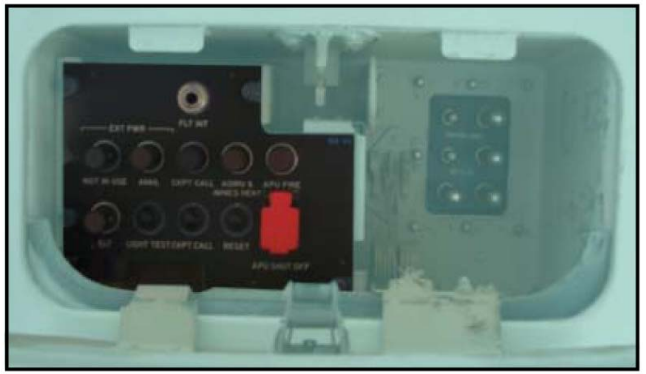
OPERATION - APU AND GEN1 RUNNING

EXTERNAL POWER SUPPLY GENERAL DESCRIPTION (2)

EXTERNAL POWER SUPPLY

The aircraft network can be supplied by a Ground Power Unit (GPU) connected to the external power (EXT PWR) receptacle located forward of the nose landing gear well.

UGB13131 - U7ST0M0 - UM24P3000000001



EXTERNAL POWER PANEL

EXTERNAL POWER SUPPLY

EXTERNAL POWER SUPPLY GENERAL DESCRIPTION (2)

EXTERNAL POWER CONTROL

NORMAL PARAMETERS

If the external power parameters are correct, [the indicator lights on the external power panel and the AVAILable light on the EXT PWR P/BSW come on. [The power parameters are monitored by the Ground and Auxiliary Power Control Unit (GAPCU) which activates the indicator lights. [With such indications the ground cart can supply the aircraft network. When the EXT PWR P/BSW is pushed, [the ON blue legend illuminates and the GAPCU closes the [External Power Contactor (EPC) to supply the aircraft electrical network. [The Bus Tie Contactors (BTCs) 1 and 2 close if no engine driven generator is on line.
The blue ON light, in the EXT PWR P/BSW, indicates that the EPC is closed.

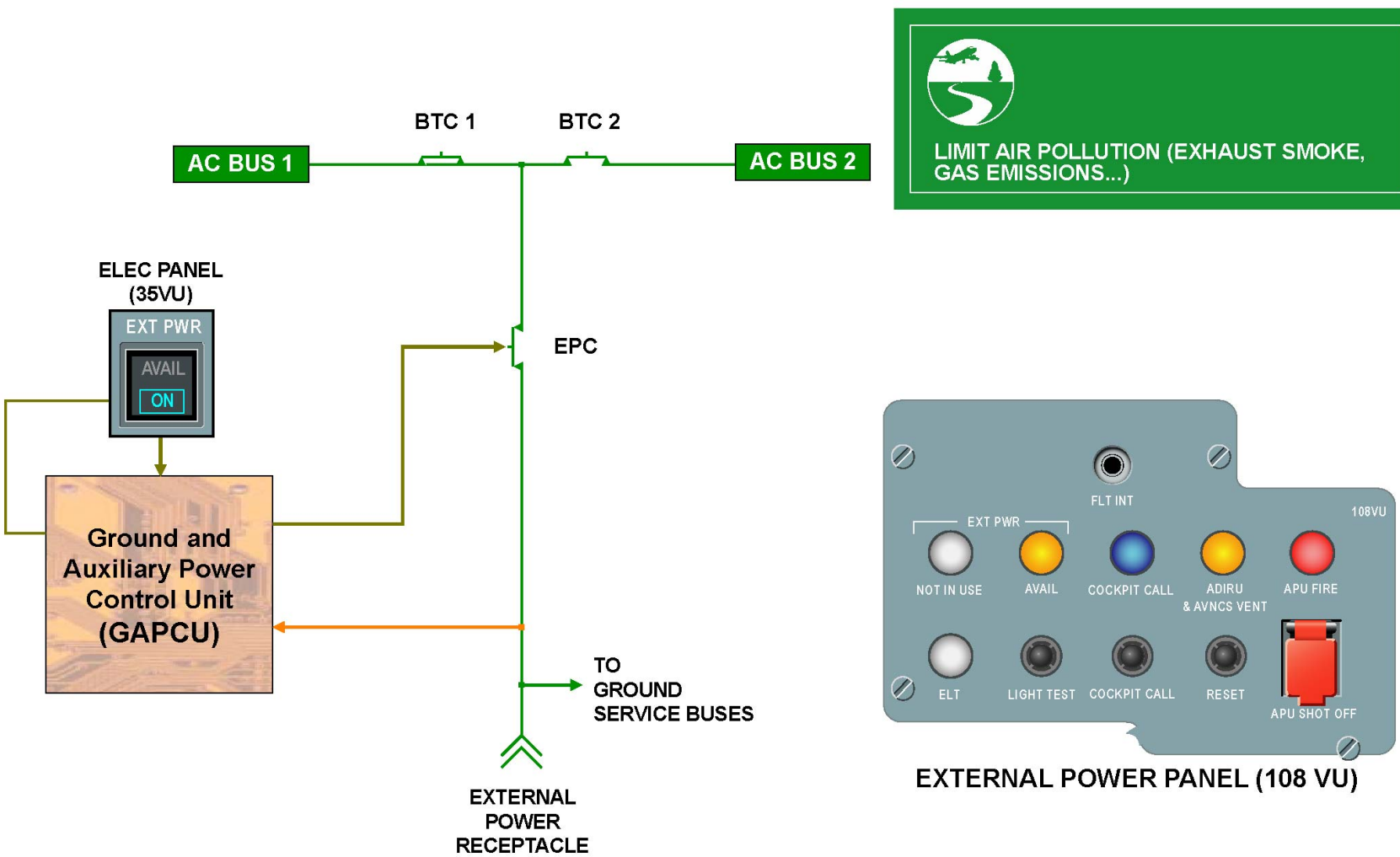
ABNORMAL PARAMETERS

If any external power parameter is not correct, the indicator lights stay off. The external power cannot be connected to the aircraft network.

ENVIRONMENTAL PRECAUTIONS

Avoid use of the APU if APU BLEED air is not necessary.
Turn-off unused ground service equipment (GPU, Air conditioning cart, etc...) if no work is being done or nobody is present on the aircraft.

UGB13131 - U7ST0M0 - UM24P3000000001



EXTERNAL POWER CONTROL - NORMAL PARAMETERS ... ENVIRONMENTAL PRECAUTIONS

EXTERNAL POWER SUPPLY D/O (3)

GENERAL

The Ground Power Unit (GPU) supplies the Transfer Circuit through the External Power Contactor (EPC).A Ground and Auxiliary Power Control Unit (GAPCU) controls and protects the connection and disconnection of the GPU and the APU generator to the network.

GROUND POWER CONTROL & MONITORING

DESCRIPTION

The 115V AC, 400 Hz, 3 phase output of the GPU is connected to the aircraft network through the EPC and Bus Tie Contactors (BTCs).The GAPCU monitors permanently the quality of the delivered ground power. The monitoring and control of the connection and disconnection is made by two internal relays. The Interlock Monitoring Relay (IMR) and the Power Ready Relay (PRR). At least one faulty parameter opens both relays.

PRR AND IMR POWER SUPPLY

The IMR is energized when:
- The interlock voltage is more than 13V DC, less than 42V DC and less than 60V AC.
- All control and protection parameters are valid.

The PRR is energized when:
- The external power interlock is valid,
- And all parameters are correct.

The annunciators NOT IN USE and AVAILABLE located on the external power panel are ON.

SHORT CIRCUIT PROTECTION (PTC)

If a short circuit occurs on the PRR output line sensed by the Positive Temperature Coefficient (PTC) sensor, the red PTC TRIP LED on the front face of the GAPCU comes on and a BITE message is sent to the Centralized Fault Display System (CFDS).

OPERATION

EXT PWR NOT IN USE (AVAILABLE)

When the Maintenance Bus switch is selected to ON, the Not In Use legend comes off on the External Electrical power panel and the GPU then supplies the A/C service buses. The AVAIL legend remains on, on the 35VU.

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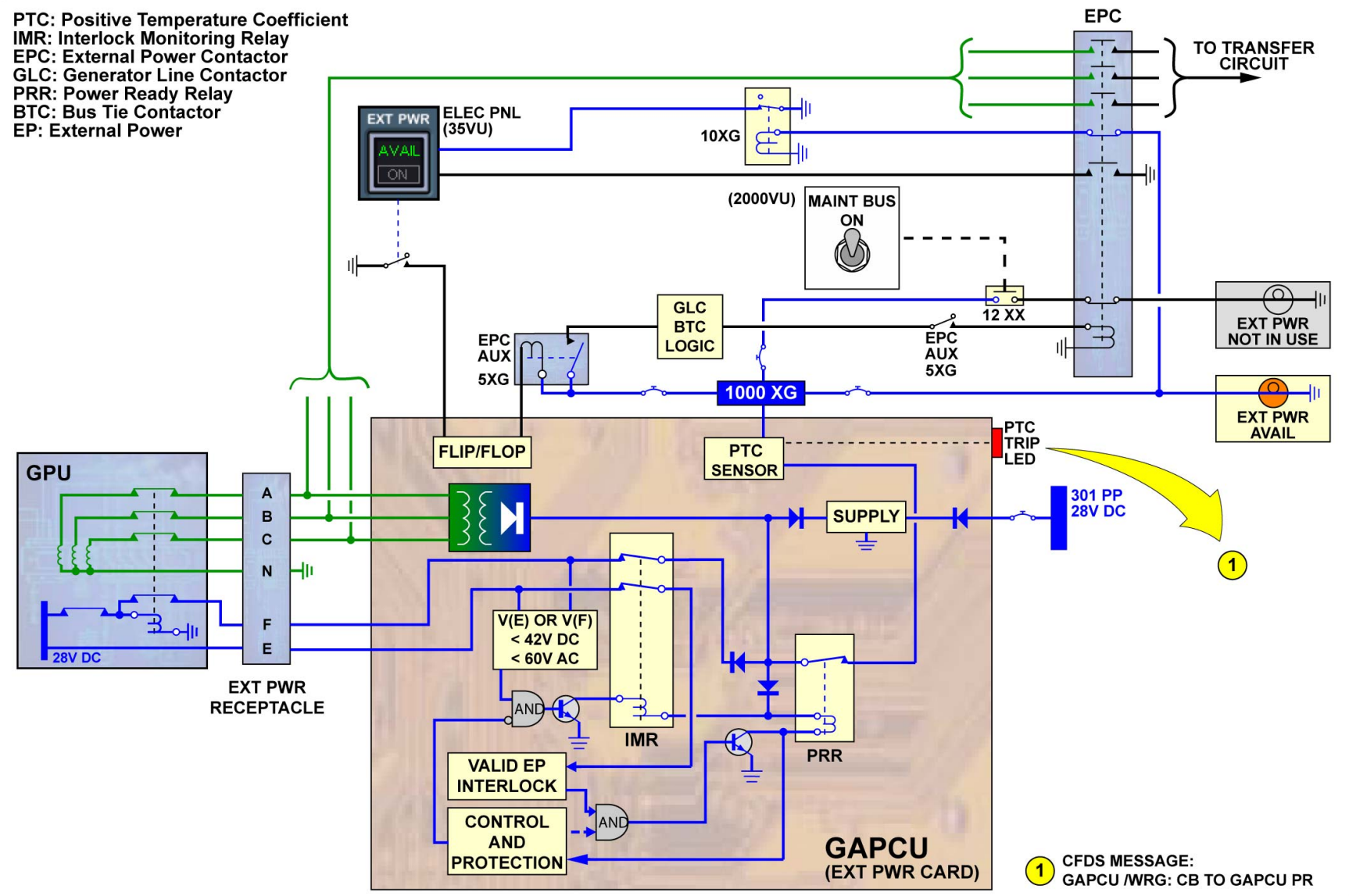


GENERAL ... OPERATION

EXTERNAL POWER SUPPLY D/O (3)

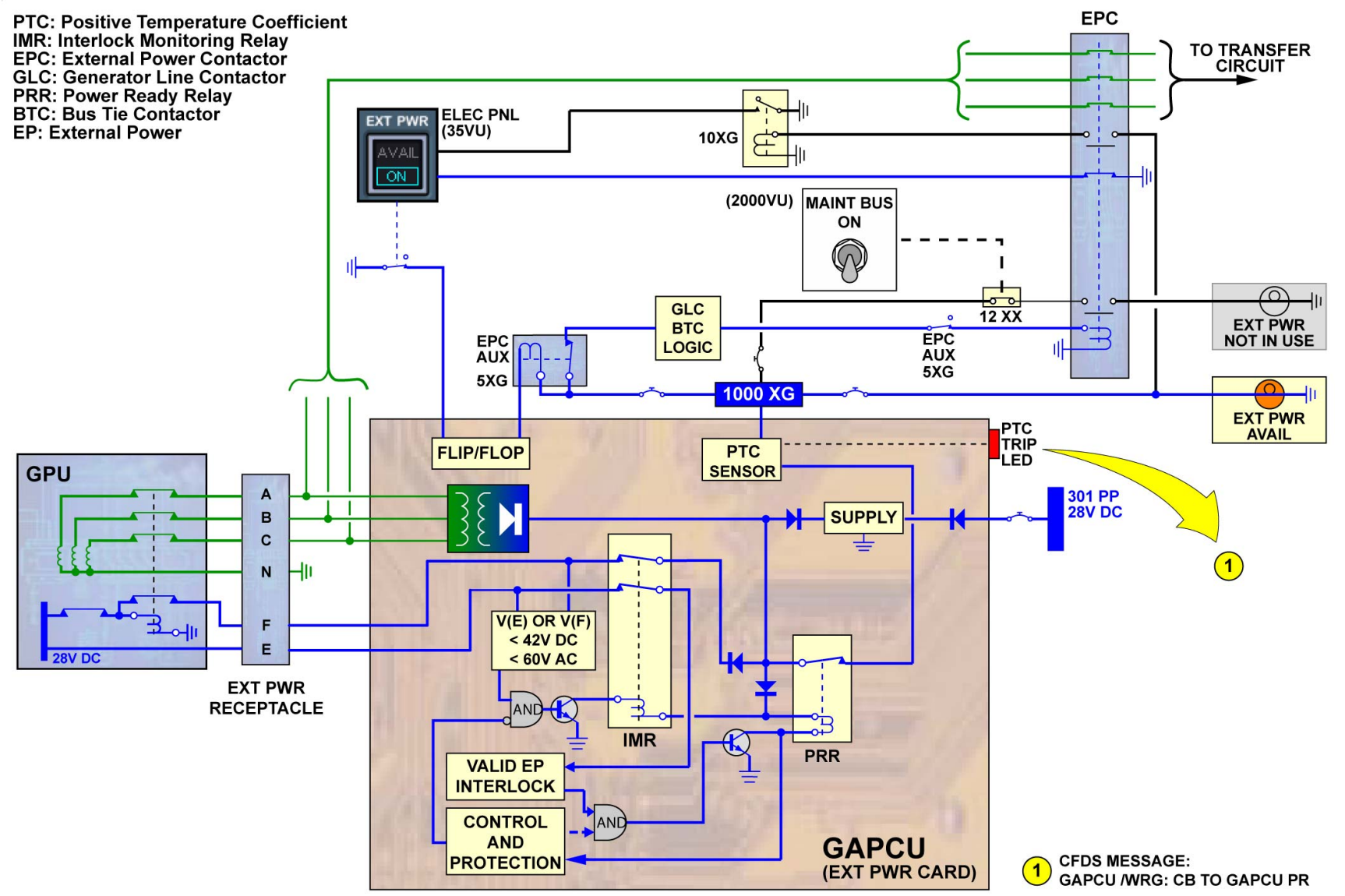
OPERATION (continued)

EXT PWR IN USE (ON)

When the External Power (EXT PWR) P/B switch is pressed (momentary switch action), the flip flop sends a ground signal to the solenoid of the EPC auxiliary relay 5XG. The relay connects power from 1000XG to the GLC/BTC logic. Depending on the supply status the logic will authorize the closure of the EPC.
At the External Power panel:
- The NOT IN USE light will extinguish,
- The AVAIL light remains ON.

On the EXT PWR switch in the cockpit:
- The AVAIL light extinguishes,
- The ON light comes ON.

UGB13131 - U7ST0M0 - UM24D8000000001



OPERATION - EXT PWR IN USE (ON)

GAPCU D/O (3)

GENERAL

The Ground and Auxiliary Power Control Unit (GAPCU) controls the APU Generator (GEN) and the External Power System. The APU Generator Line Contactor (GLC), the External Power Contactor (EPC) and their related Auxiliary Relays can only close when the correct conditions exist. They are opened manually or automatically, by the control and protection circuits.
The GAPCU also performs BITE analysis and communication, and interfaces with other systems:
- Generator Control Units (GCUs),
- APU Electronic Control Box (ECB),
- Centralized Fault Display Interface Unit (CFDIU),
- System Data Acquisition Concentrators (SDACs),
- Landing Gear Control and Interface Unit (LGCIU) 1.

POWER SUPPLY

The GAPCU internal power supply module can be supplied by the external power or the APU GEN via internal Transformer/Rectifiers (TRs). The supply module also has a back up supply from the BAT BUS.

EXT PWR CONTROL

The GAPCU performs the following functions for the external power control and BITE:
- monitoring,
- interlock function,
- External Power Contactor (EPC) control,
- protection,
- BITE function,
- communication and interface.

MONITORING

The GAPCU permanently monitors the quality of the external power supply. A faulty parameter automatically disconnects the external power from the transfer line opening the Power Ready Relay (PRR) to open the EPC, and Interlock Monitoring Relay (IMR) to trip the ground cart. In some GAPCU failure conditions, the back-up card can control the PRR, so that the external power can still be connected to the aircraft. In these cases, after a "cold reset" the PRR closes and the external power is supplied to the aircraft with limited protection. In that case, no bite function is available.

EPC CONTROL

The closed PRR provides 28V DC to the solenoid of the EPC AUX relay (5XG). The AUX relay is responsible for opening and closing of the main contactor (EPC). The EPC AUX relay is also responsible for the priority switching, i.e. the External Power over the APU GEN. When the EXT PWR P/BSW is pressed the FLIP/FLOP provides a fixed ground signal to close the EPC AUX relay. Depending on the network supply status, the EPC AUX relay connects power via the de-energized APU GLC, to the EPC. The EPC then connects the GPU to the transfer line. When the EXT PWR P/BSW is pressed again, the FLIP/FLOP removes the ground so that the AUX relay and EPC open.

PROTECTION

The GAPCU performs the following protection functions for the external power:
- over and under voltage,
- over and under frequency,
- over current,
- overload,
- EXT PWR interlock,
- Incorrect Phase Sequence (IPS),
- open cable or open/short circuit,

- EPC failure.

The Over Voltage (OV) protection is accomplished by monitoring the highest phase voltage at the Point Of Reference (POR). An OV condition exists when the highest phase voltage exceeds 130 +/- 1,5V AC. After an inverse delay, the IMR, PRR and EPC are tripped.

The Under Voltage (UV) is sensed in the same way as OV. An UV condition exists when the lowest phase voltage is less than 101,5 +/- 1,5V AC. After a 4,5 second time delay max, the PRR, IMR and EPC are tripped.

An over current on the wiring between the PRR and the aircraft bus (1000XG) will change the status of the Positive Temperature Coefficient (PTC) sensor (high impedance). The sensor then provides a signal to switch on the red PTC LED on the front face of the GAPCU and sends a BITE message to the Centralized Fault Display System (CFDS).

The PTC and the PTC LED are only supplied if the EXT PWR remains connected to the receptacle (i.e. PRR is still closed). The LED is not a "latched" status signal. Thus, if a short circuit does exist, and the LED is illuminated, it will go off as soon as the external power is removed from the receptacle.

APU GEN CONTROL

The main functions are:

- control of the field excitation through the Generator Control Relay (GCR),
- voltage regulation,
- control of the APU GLC through the PRR in conjunction with the BTC/GLC logic,
- control and protection of the APU GEN and the network.

APU P/BSW

The APU GEN P/BSW is used to connect or disconnect the APU GEN and to reset the APU GEN control part. After a fault detection (tripping of the generator), the control and must be reset by setting the P/BSW to OFF and back to on.

APU GLC CONTROL AND MONITORING

The APU GLC is under control of the APU GLC AUX relay and the GLC/BTC logic. If all APU GEN parameters are correct, the APU GLC connects the APU GEN power to the transfer line.

overheat protection

An oil temperature bulb is installed on the APU GEN oil outlet port. The bulb is directly connected to the APU ECB. In case of oil temperature above 185°C, the ECB commands an immediate shutdown of the APU.

COMMUNICATION AND INTERFACE

The GAPCU is connected with the GCUs, the CFDIU and the SDACs.

WITH THE GCU

The GAPCU communicates with the two GCUs via MIL-STD 1553 links.

WITH THE CFDIU

The GAPCU is the CFDS interface for the enhanced Electrical Power Generation System (EPGS). The GAPCU communicates with the CFDIU via ARINC 429 links. During normal mode of transmission, the GAPCU continuously sends its own and the two GCUs fault data, to the CFDIU.

WITH THE SDAC

The GAPCU continuously communicates with the SDACs via ARINC 429 links. The SDACs provide system data and fault data to the ECAM.

INTERFACE WITH LGCIU 1

The GAPCU receives a flight/ground discrete signal from LGCIU 1. It enables communication in interactive mode between the GCU and the GAPCU and the CFDIU, when the aircraft is on ground.

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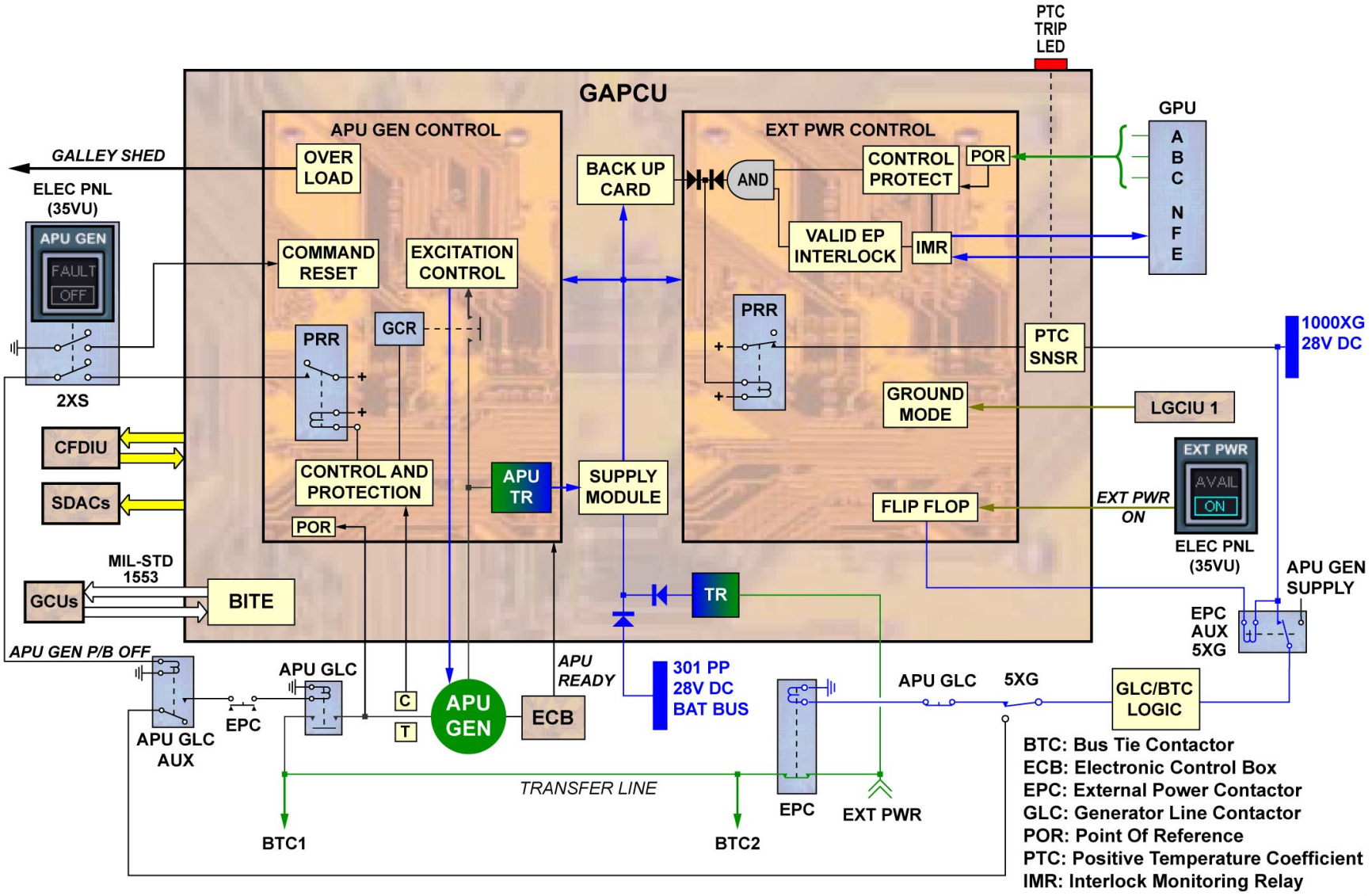


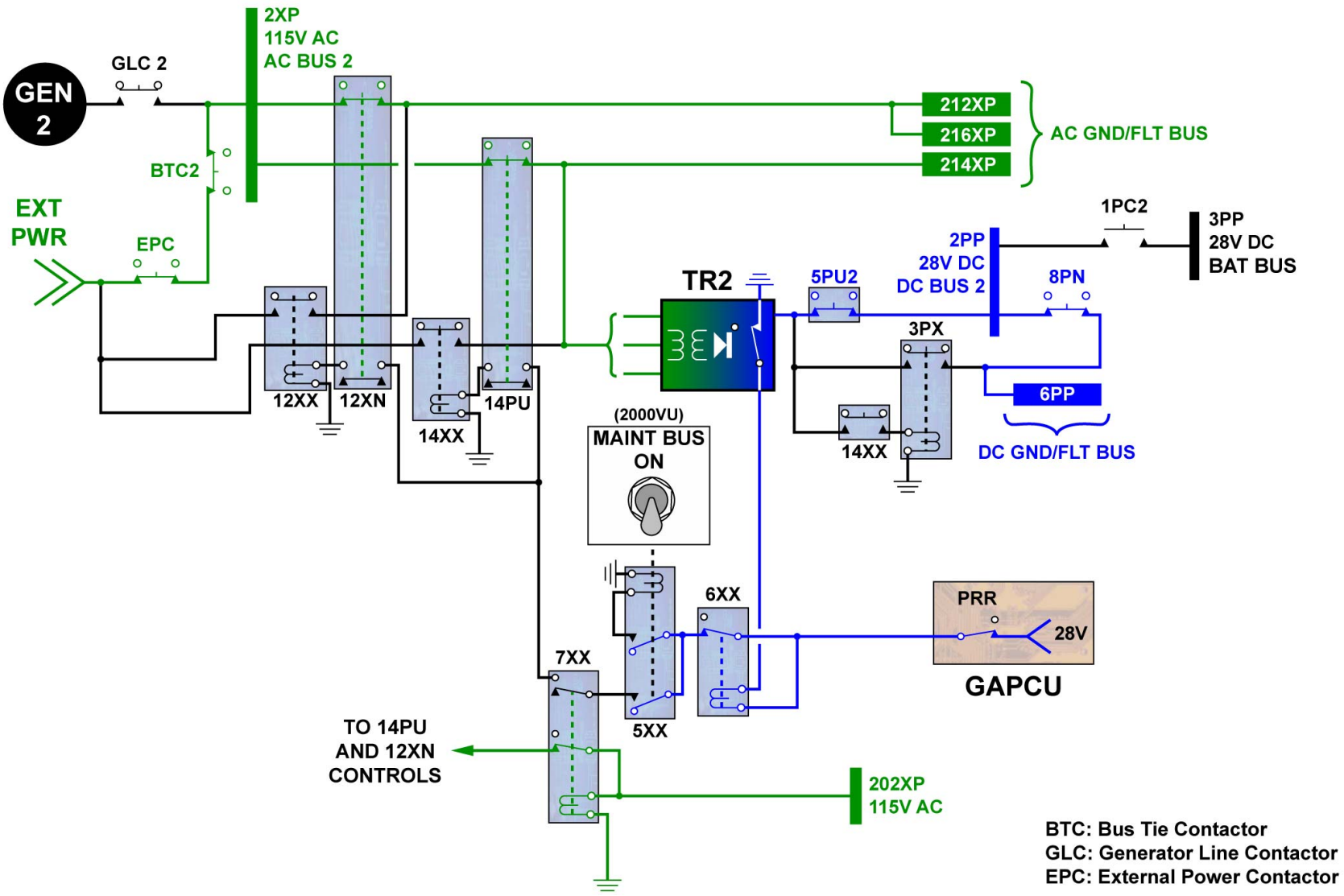
GENERAL ... COMMUNICATION AND INTERFACE

AC/DC GROUND SERVICE DISTRIBUTION D/O (3)

EXT PWR P/B ON

With the EXTernal PoWeR available and the EXT PWR P/B on, the whole aircraft electrical network is supplied including the AC and DC GrouND/FLighT buses. The MAINTenance BUS switch (5XX) is off.

UGB13131 - U7ST0M0 - UM24DA000000002


GEN 2
GLC 2
2XP
115V AC
AC BUS 2
BTC2
EXT PWR
EPC
212XP
216XP
214XP
AC GND/FLT BUS
1PC2
3PP
28V DC
BAT BUS
2PP
28V DC
DC BUS 2
8PN
TR2
5PU2
3PX
6PP
DC GND/FLT BUS
12XX
12XN
14PU
14XX
14XX
(2000VU)
MAINT BUS
ON
6XX
7XX
5XX
PRR
28V
GAPCU
TO 14PU
AND 12XN
CONTROLS
202XP
115V AC
BTC: Bus Tie Contactor
GLC: Generator Line Contactor
EPC: External Power Contactor

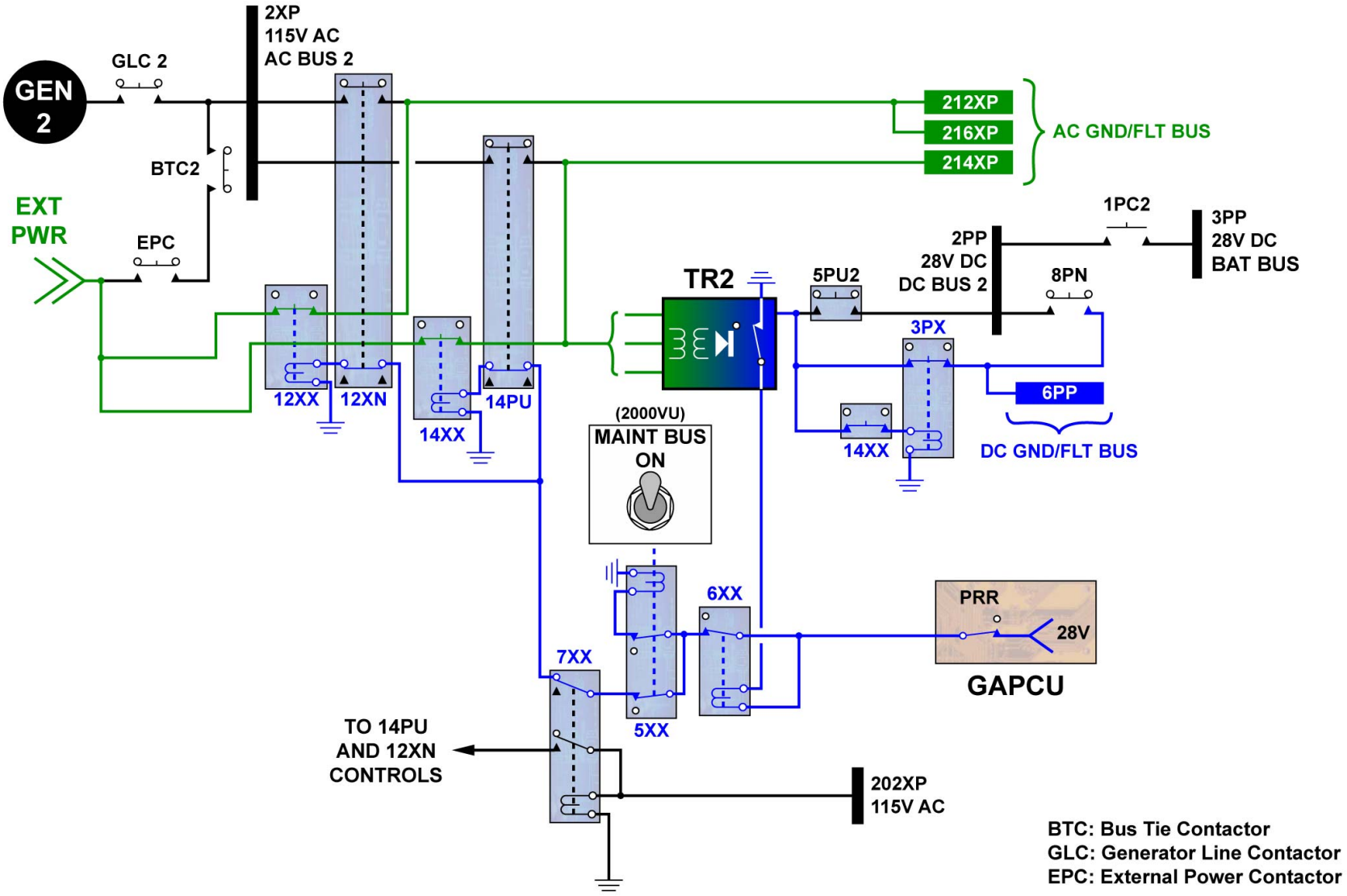
EXT PWR P/B ON

AC/DC GROUND SERVICE DISTRIBUTION D/O (3)

MAINT BUS SW ON

EXT PWR is available but not on (14PU and 12XN open) and the MAINT BUS switch switched to ON. [AC BUS 2 and 202XP are not energized, so [relay 7XX is de-energized and supplies [relay 14XX via relay 14PU and relay 12XX via relay 12XN. With these two relays energized, [the DC GND/FLT bus (6PP) is supplied via Transformer Rectifier (TR) 2 and the [AC GND/FLT buses (212XP, 216XP and 214XP) via 12XX and 14XX.

UGB13131 - U7ST0M0 - UM24DA000000002



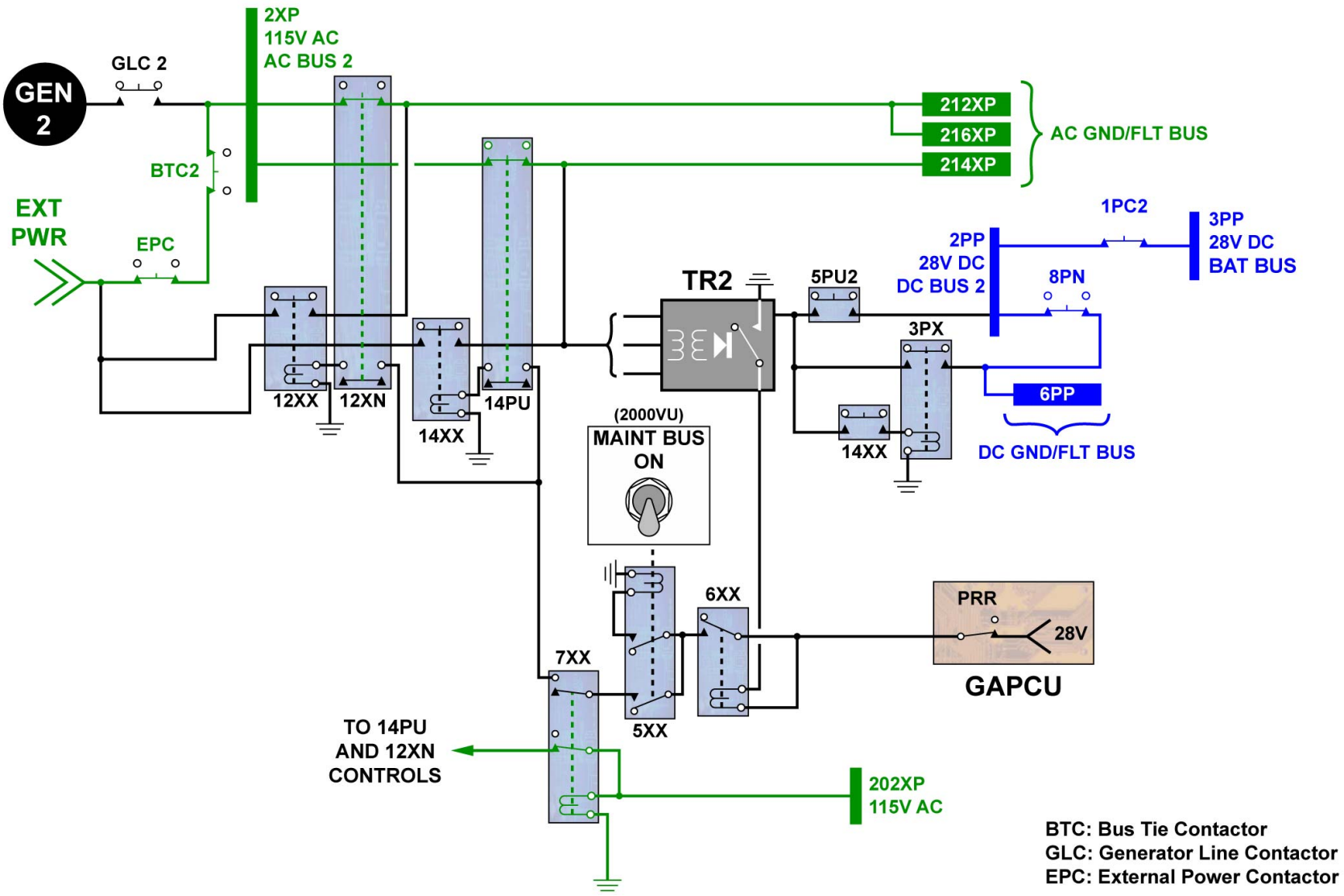
MAINT BUS SW ON

AC/DC GROUND SERVICE DISTRIBUTION D/O (3)

TR2 FAILURE WITH EXT PWR ON

If TR2 fails [the GND/FLT buses are automatically supplied from TR1
via [DC BUS 1, battery BUS and DC BUS 2.

UGB13131 - U7ST0M0 - UM24DA000000002



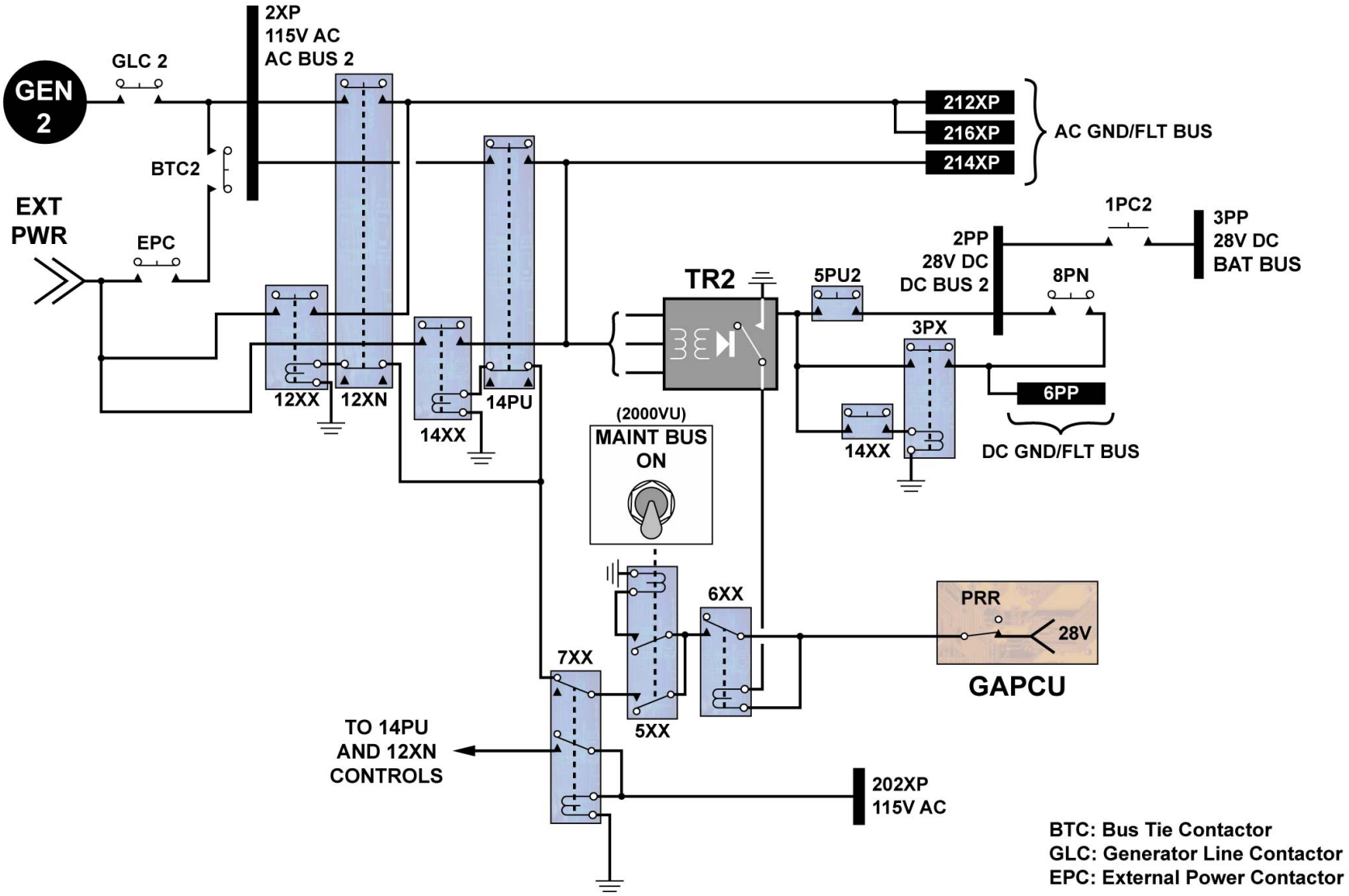
TR2 FAILURE WITH EXT PWR ON

AC/DC GROUND SERVICE DISTRIBUTION D/O (3)

TR2 FAILURE WITH MAINT BUS SW ON

If the GND/FLT buses are supplied (MAINT BUS switch on) and [TR2 has an internal overheat (T>172°C) [the MAINT BUS switch trips off because relay 6XX is de-energized. Thus, relays 12XX and 14XX are also de-energized so there is no power supply to any of the AC and DC GND/FLT buses.

UGB13131 - U7ST0M0 - UM24DA000000002



TR2 FAILURE WITH MAINT BUS SW ON

BUS TIE LOGIC D/O (3)

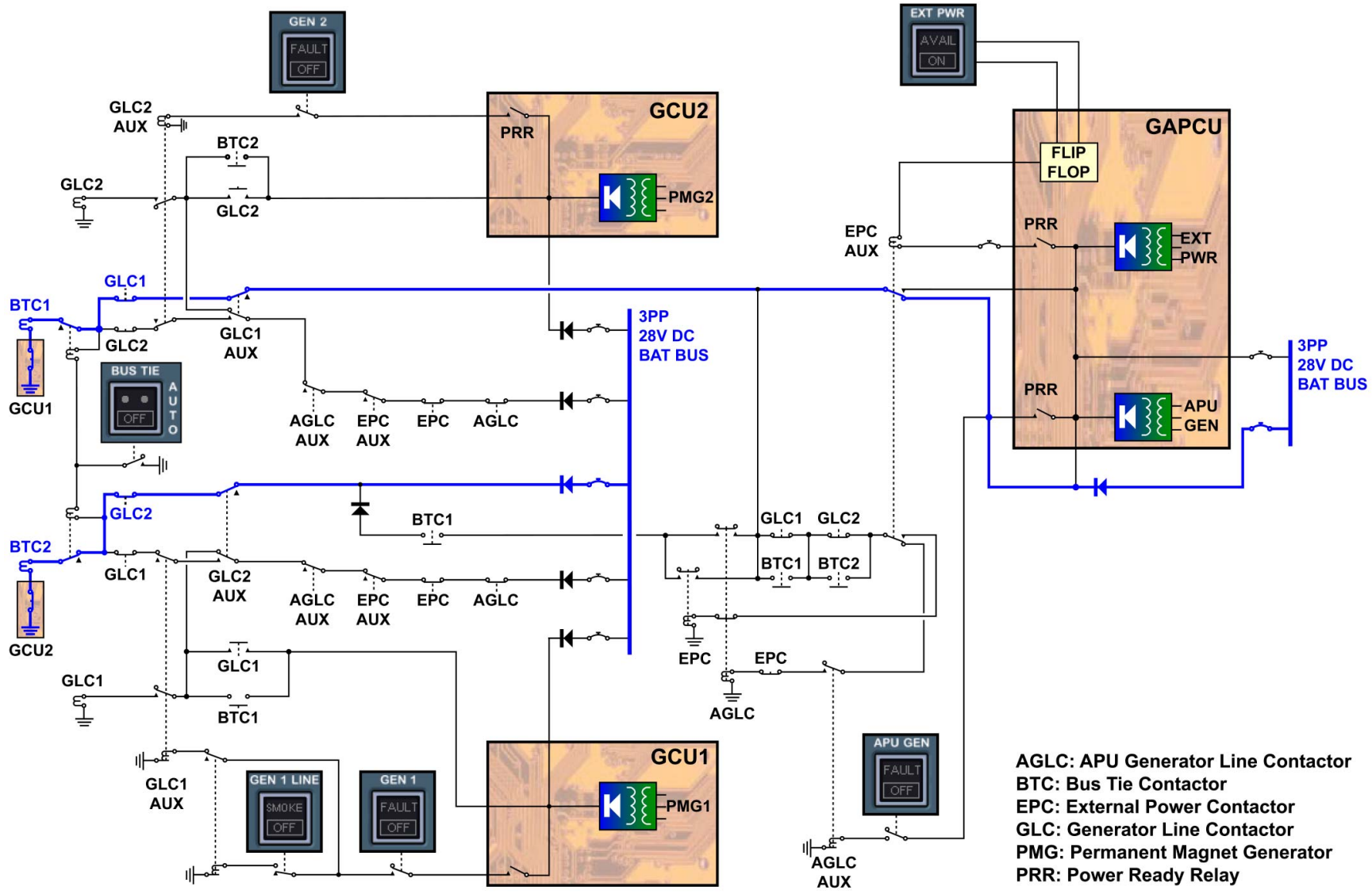
GENERAL

The Bus Tie Logic is responsible for the following tasks:
- No parallel operation of two power sources on the transfer line or busbars.
- Automatic power transfer in case of a supply failure.
- The priority of Power Sources to supply the AC BUSES.
The order of these priorities is:
1- On side Integrated Drive Generator (IDG) to own busbars, the IDG 1 to AC BUS 1 and the IDG 2 to AC BUS 2.
2- External Power (EXT PWR).
3- APU Generator (APU GEN).
4- Opposite IDG (IDG 1 to AC BUS 1 and 2 or IDG 2 to AC BUS 2 and 1).

BATTERIES CONNECTED

With battery power only, the BTCs are closed because all the other contactors and auxiliary relays are open. The BTC power supply is from the BAT BUS. When APU GEN or EXT PWR are available, the BTC power supply is provided by the Ground and Auxiliary Power Control Unit (GAPCU).
Note: The BTC ground path is provided by the related Generator Control Unit (GCU). This is a protection against Over Current. It inhibits an automatic transfer to a network fault, by inhibiting the BTC close logic (BTC lockout).

UGB13131 - U7ST0M0 - UM24DB000000001



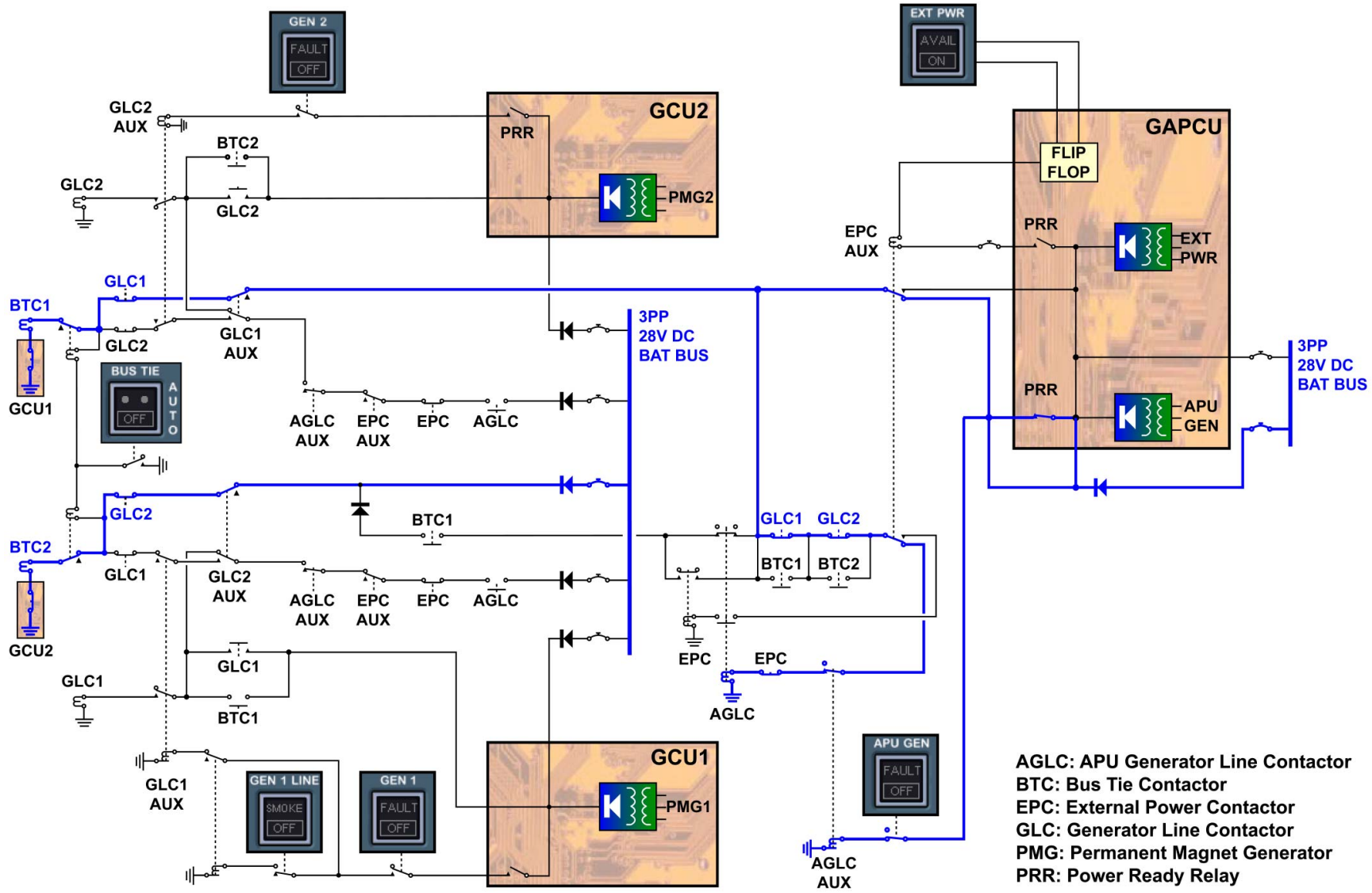
GENERAL & BATTERIES CONNECTED

BUS TIE LOGIC D/O (3)

APU GEN SUPPLY

When the APU GEN is the only power source, Bus Tie Contactor (BTC) 1 and 2 close to supply the entire AC power network. The APU Generator Line Contactor (AGLC) is closed, because GLC 1, GLC 2 and the External Power Contactor (EPC) are open (priority logic).

UGB13131 - U7ST0M0 - UM24DB000000001



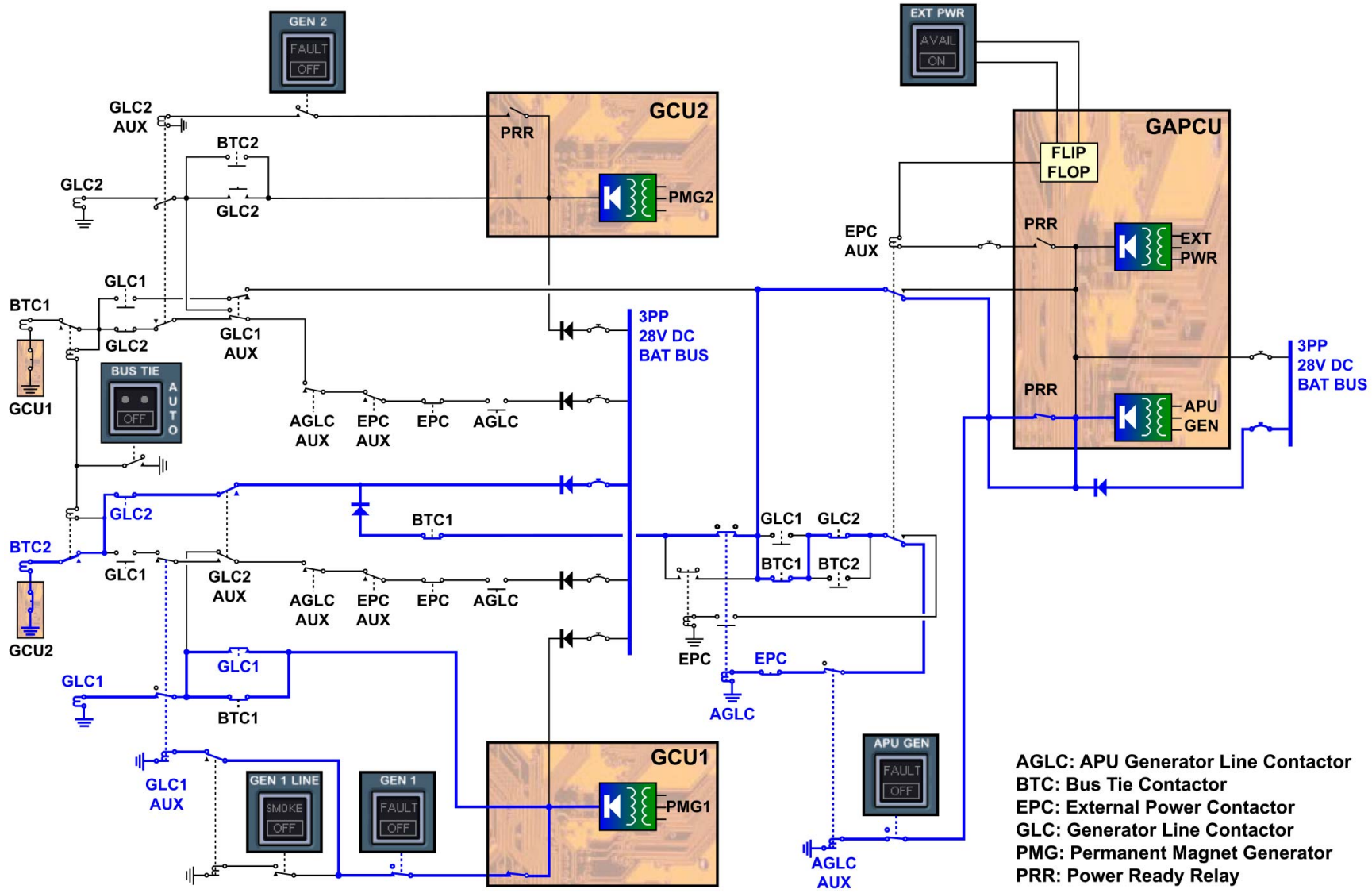
APU GEN SUPPLY

BUS TIE LOGIC D/O (3)

APU GEN AND GEN 1 SUPPLY

With APU GEN and GEN 1 supplying the network, BTC 1 should be open to avoid parallel operation with GEN 1 and the APU GEN.
BTC 2 should be closed to connect the APU Generator to AC BUS 2.

UGB13131 - U7ST0M0 - UM24DB000000001



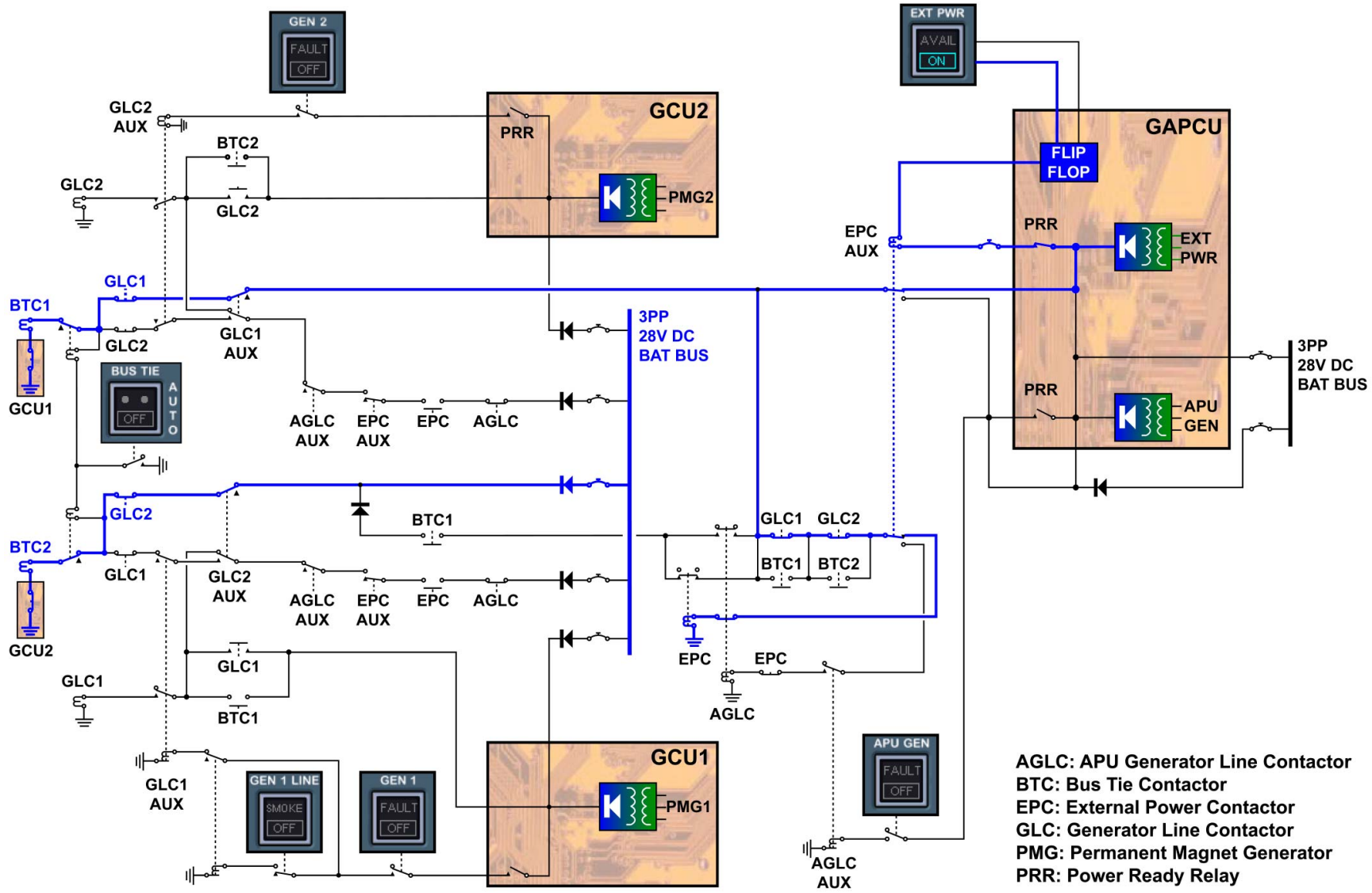
APU GEN AND GEN 1 SUPPLY

BUS TIE LOGIC D/O (3)

EXT PWR ON ONLY

With only EXT PWR on, both BTCs should be closed to supply AC BUS 1+2.

UGB13131 - U7ST0M0 - UM24DB000000001



EXT PWR ON ONLY

BUS TIE LOGIC D/O (3)

GEN 2 ONLY

With IDG 2 only operation, both BTCs should be closed. IDG 2 supplies its own busbar and via the closed BTCs also AC BUS 1.

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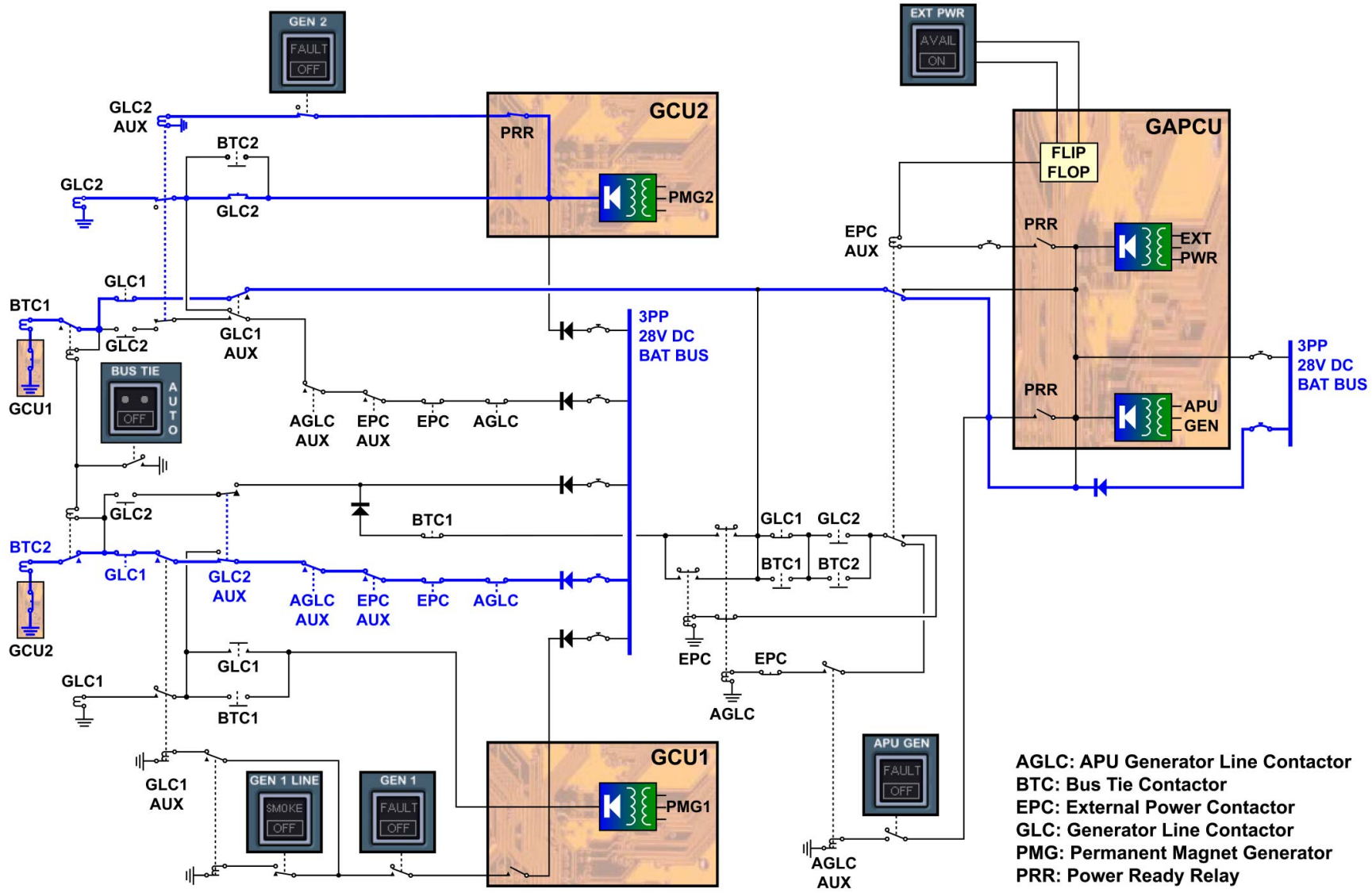

GEN 2
FAULT
OFF
EXT PWR
AVAIL
ON
GLC2
AUX
BTC2
GLC2
GLC2
PRR
GCU2
PMG2
GAPCU
FLIP
FLOP
EPC
AUX
PRR
EXT
PWR
GLC1
BTC1
GLC2
GLC1
AUX
3PP
28V DC
BAT BUS
BUS TIE
AUTO
OFF
GCU1
AGLC
AUX
EPC
AUX
EPC
AGLC
PRR
APU
GEN
3PP
28V DC
BAT BUS
GLC2
BTC1
GLC1
GLC2
BTC2
BTC1
BTC2
GLC1
GLC2
AUX
AGLC
AUX
EPC
AUX
EPC
AGLC
GCU2
EPC
EPC
AGLC
GLC1
GLC1
BTC1
GLC1
AUX
GEN 1 LINE
SMOKE
OFF
GEN 1
FAULT
OFF
GCU1
PMG1
APU GEN
FAULT
OFF
AGLC
AUX
AGLC: APU Generator Line Contactor
BTC: Bus Tie Contactor
EPC: External Power Contactor
GLC: Generator Line Contactor
PMG: Permanent Magnet Generator
PRR: Power Ready Relay

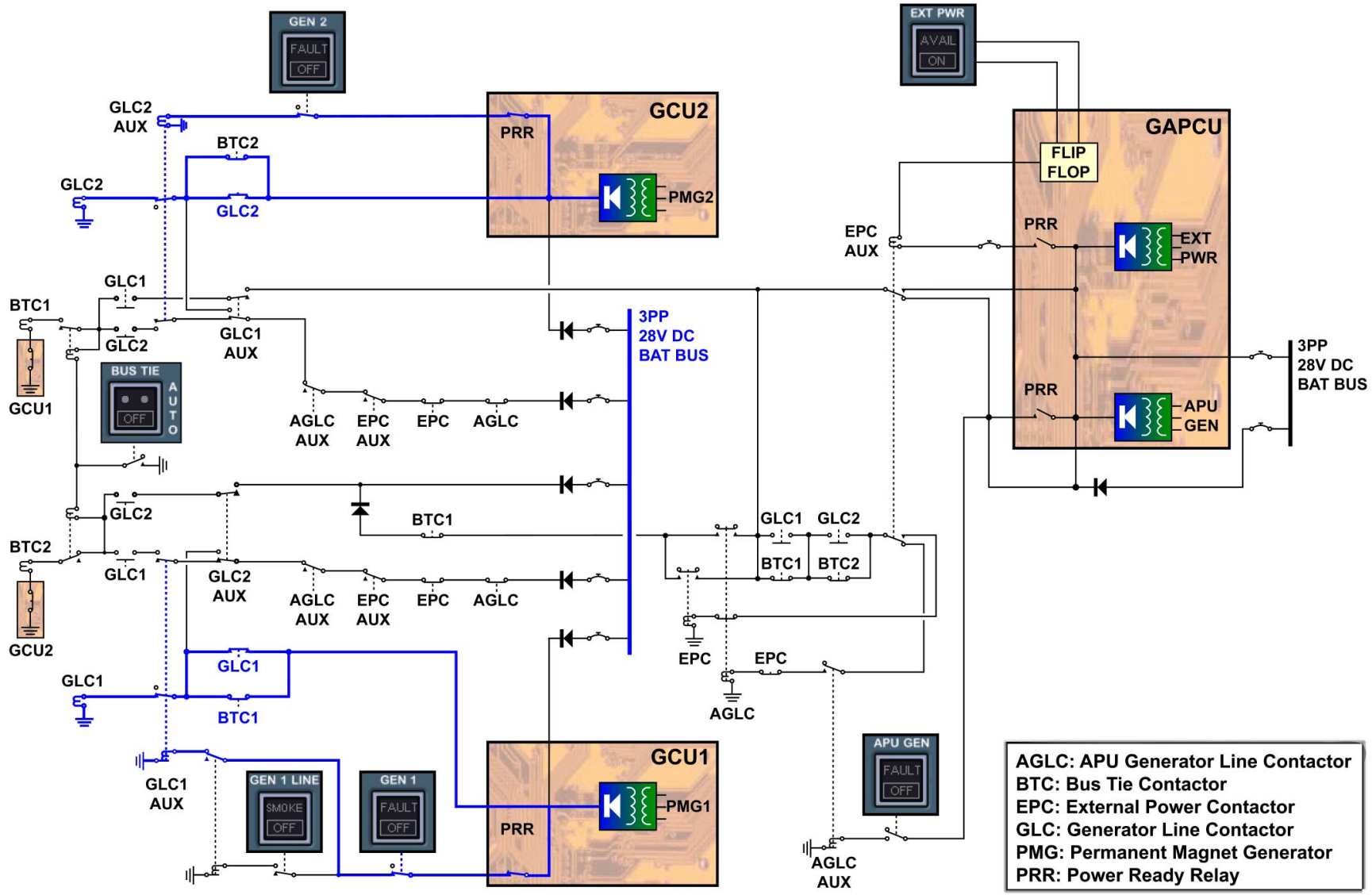
GEN 2 ONLY

BUS TIE LOGIC D/O (3)

NORMAL OPERATION

In normal operation, both BTCs stay open. IDG 1 supplies AC BUS 1 and IDG 2 supplies AC BUS 2.

UGB13131 - U7ST0M0 - UM24DB000000001



NORMAL OPERATION

UGB13131 - U7ST0M0 - UM24DB000000001

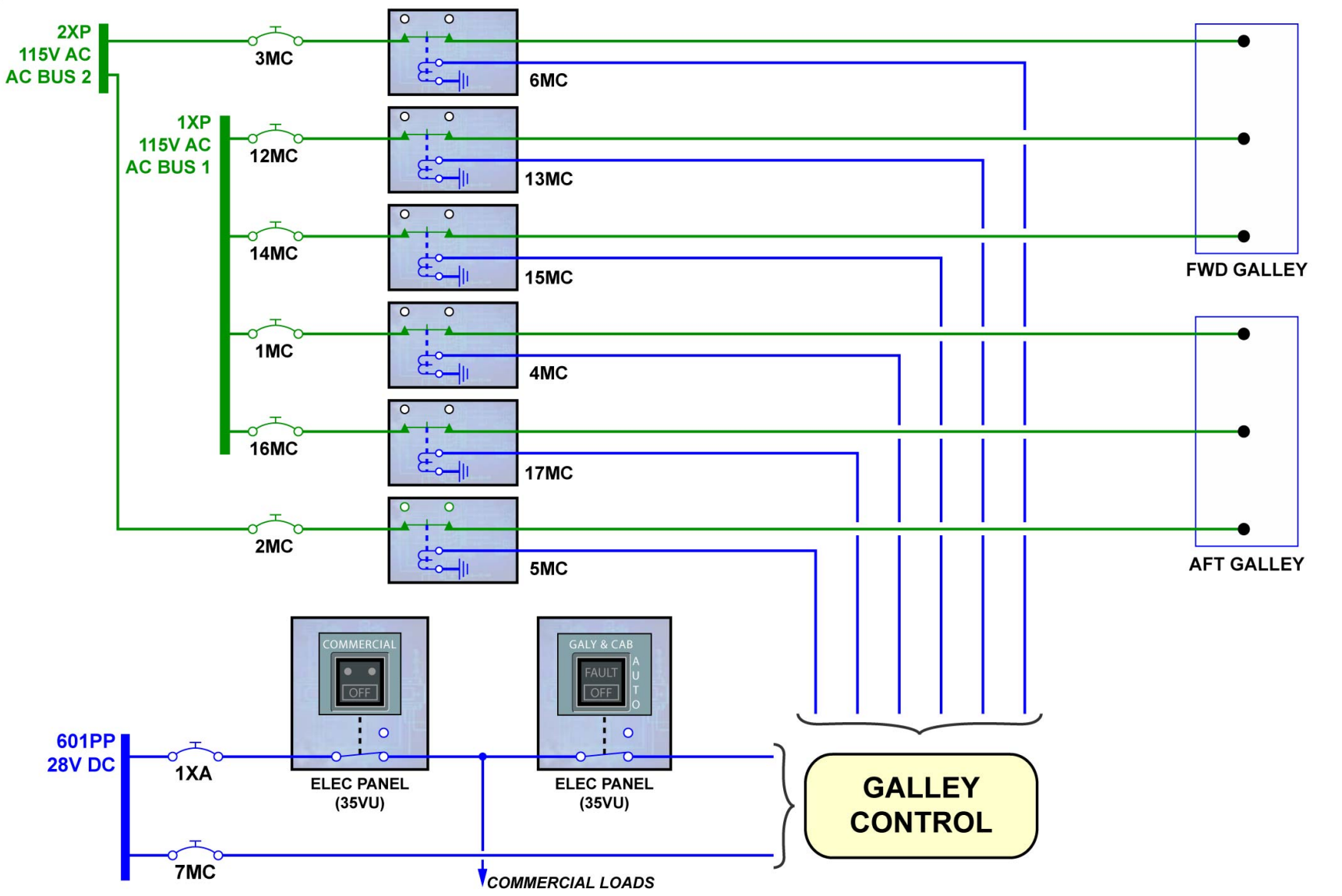
GALLEY SUPPLY D/O (3)

GENERAL

The galleys are electrically supplied by the AC normal busbars. Note that extra cabin system load buses can be added. The power supply is controlled from the GALleY & CABin and COMMERCIAL P/BSWs, connected in series.

NOTE: The maximum load for all galleys depends on the aircraft.

UGB13131 - U7ST0M0 - UM24DD000000002


2XP
115V AC
AC BUS 2
3MC
6MC
1XP
115V AC
AC BUS 1
12MC
13MC
14MC
15MC
1MC
4MC
16MC
17MC
2MC
5MC
FWD GALLEY
AFT GALLEY
COMMERCIAL
OFF
GALY & CAB
FAULT
OFF
AUTO
601PP
28V DC
1XA
ELEC PANEL
(35VU)
ELEC PANEL
(35VU)
GALLEY
CONTROL
7MC
COMMERCIAL LOADS

GENERAL

GALLEY SUPPLY D/O (3)

GALY & CAB AND COMMERCIAL P/BSW

If either the GALY & CAB P/BSW or the COMMERCIAL P/BSW is off, all galley power is removed. If the COMMERCIAL P/BSW is pressed in and the GALY & CAB P/BSW is off, all galley power is removed but the commercial buses are still supplied. Related messages are sent to the ECAM. The GALY & CAB P/BSW amber legend comes on if a generator overload is detected.

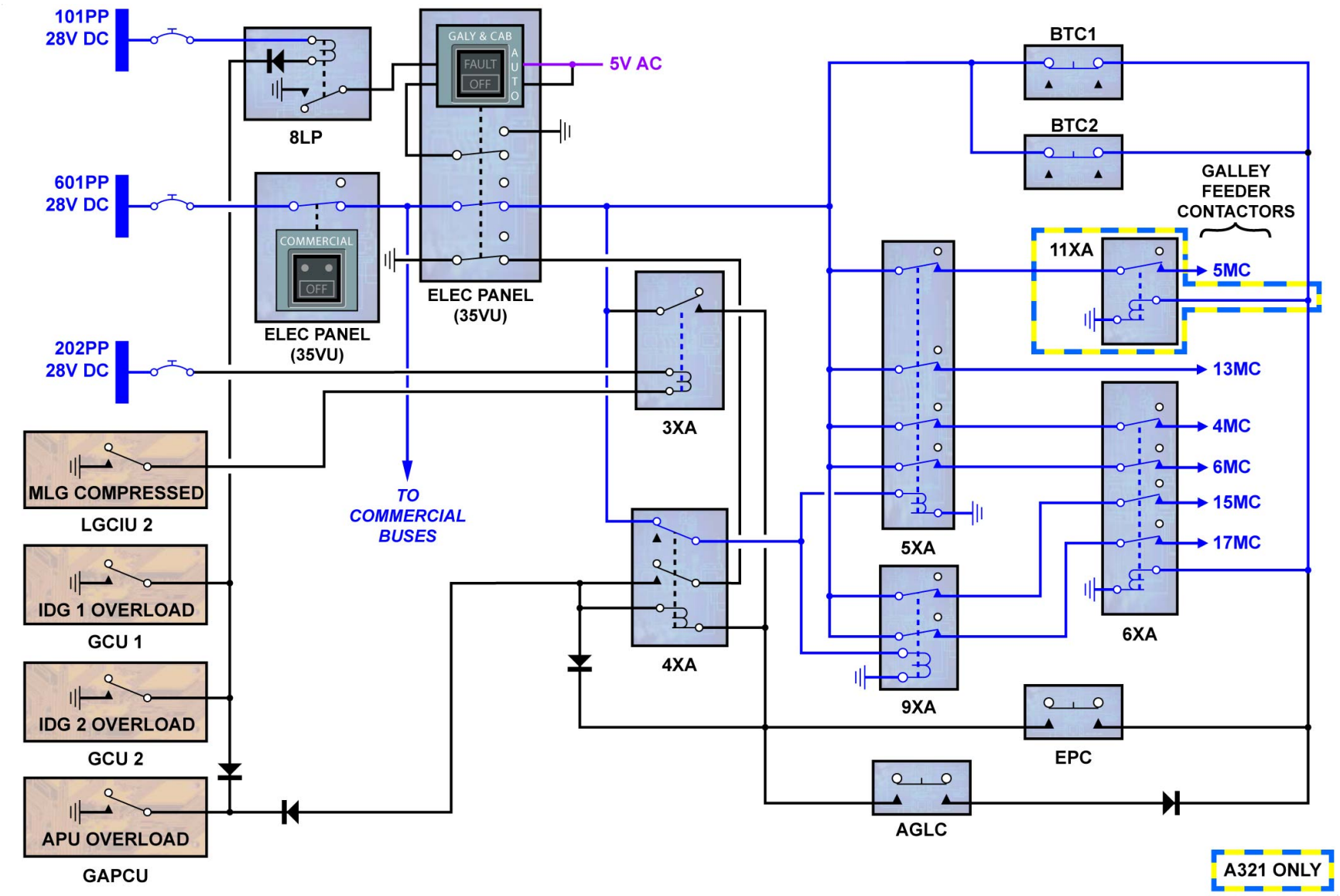
OPERATION

With the GALY & CAB and COMMERCIAL P/BSWs on and normal electrical configuration, relays 5XA, 6XA and 9XA control the galley feeder contactors and all galley buses are supplied.

NOTE: On A321 aircraft, an additional relay 11XA controls the galley feeder contactor 5MC.

IN FLIGHT WITH BOTH GENERATORS

In flight or on the ground, with both engine driven generators running, you can supply all feeders with power.



GALY & CAB AND COMMERCIAL P/BSW & OPERATION

UGB13131 - U7ST0M0 - UM24DD000000002

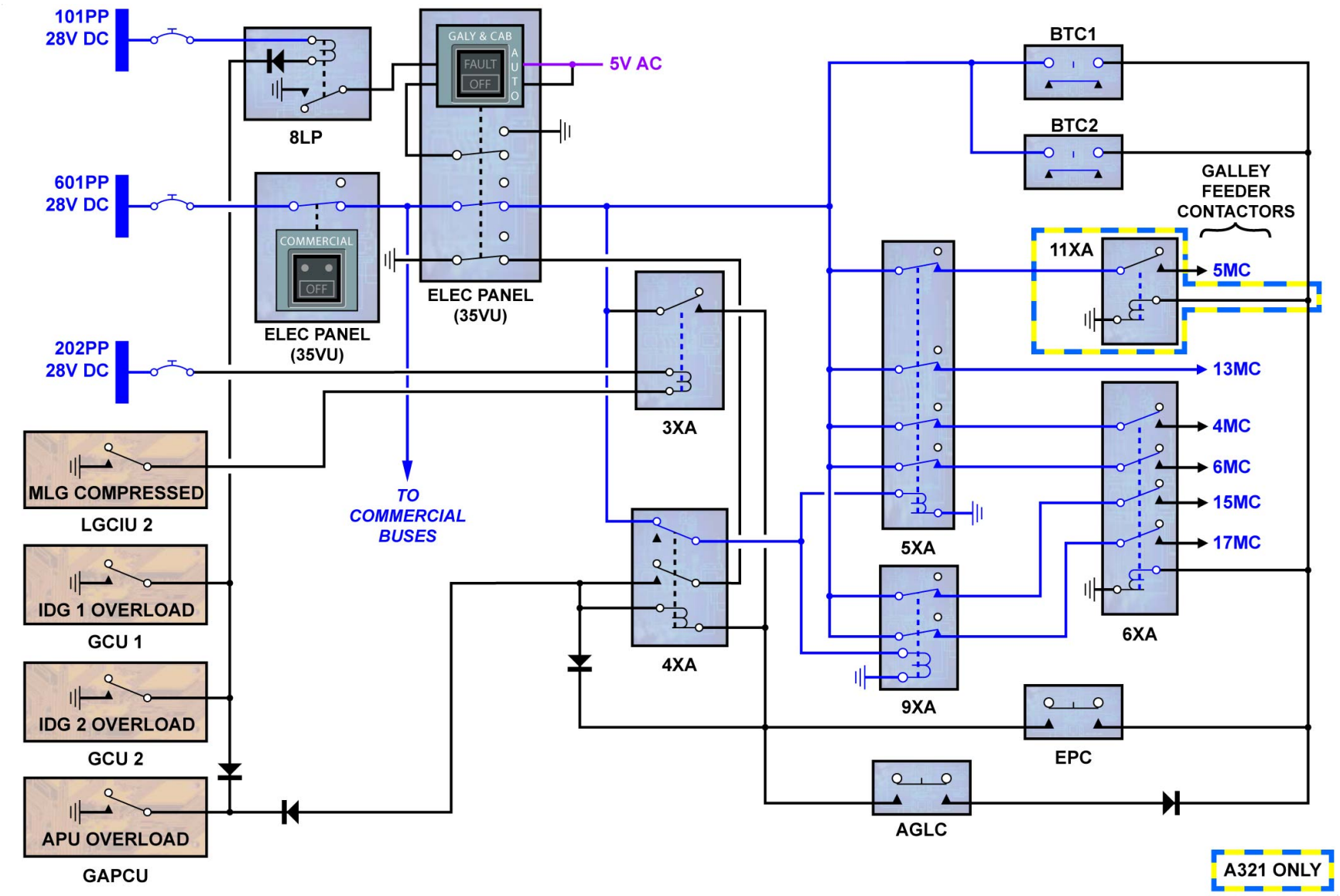
GALLEY SUPPLY D/O (3)

OPERATION (continued)

IN FLIGHT WITH ONE GENERATOR ONLY

In flight and with one AC generator online, the primary galley power supply is automatically shed. In single generator operation both Bus Tie Contactors (BTCs) energize thus de-energizing relay(s) 6XA (and 11XA for A321) which accomplishes the shedding action.

UGB13131 - U7ST0M0 - UM24DD000000002



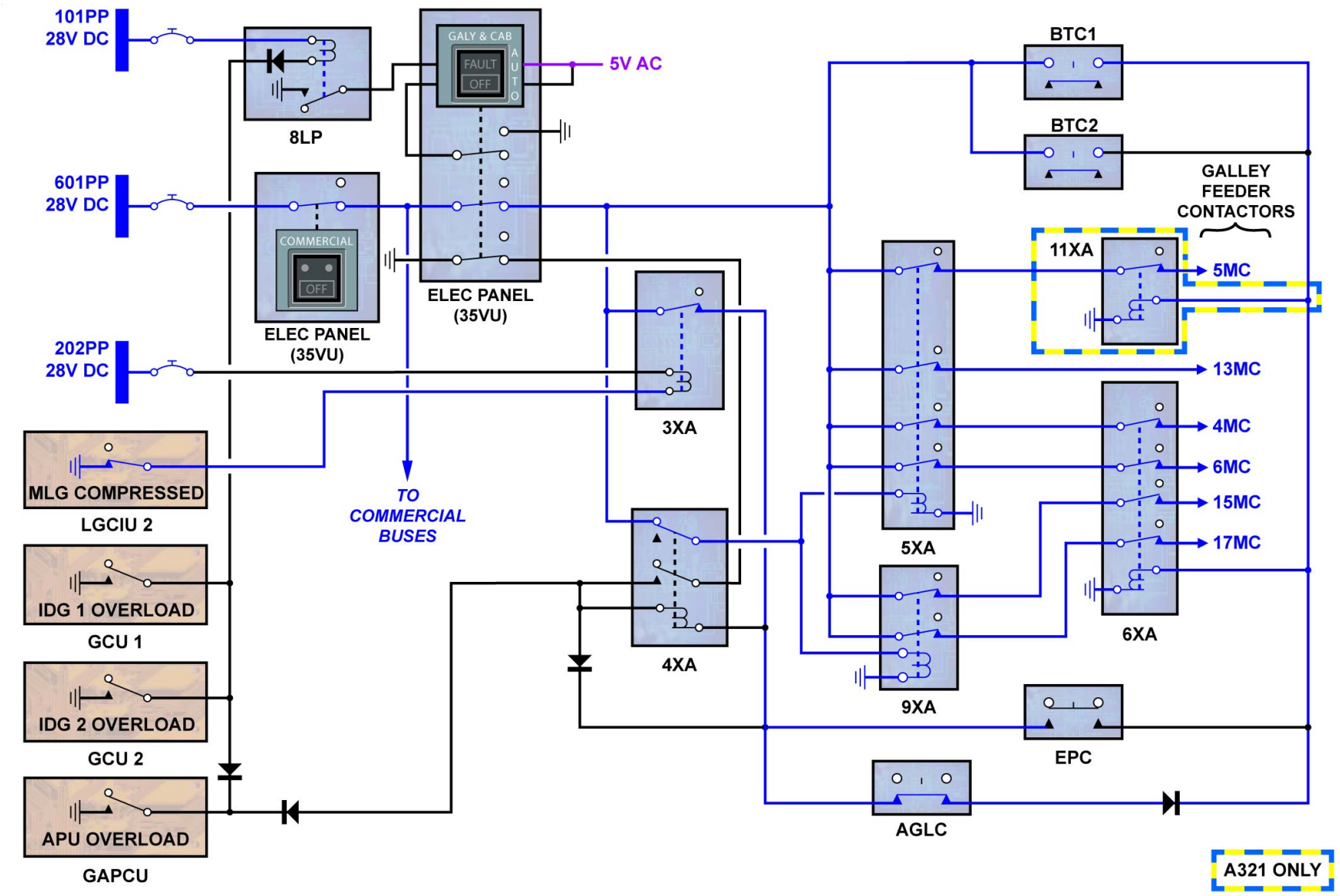
OPERATION - IN FLIGHT WITH ONE GENERATOR ONLY

GALLEY SUPPLY D/O (3)

OPERATION (continued)

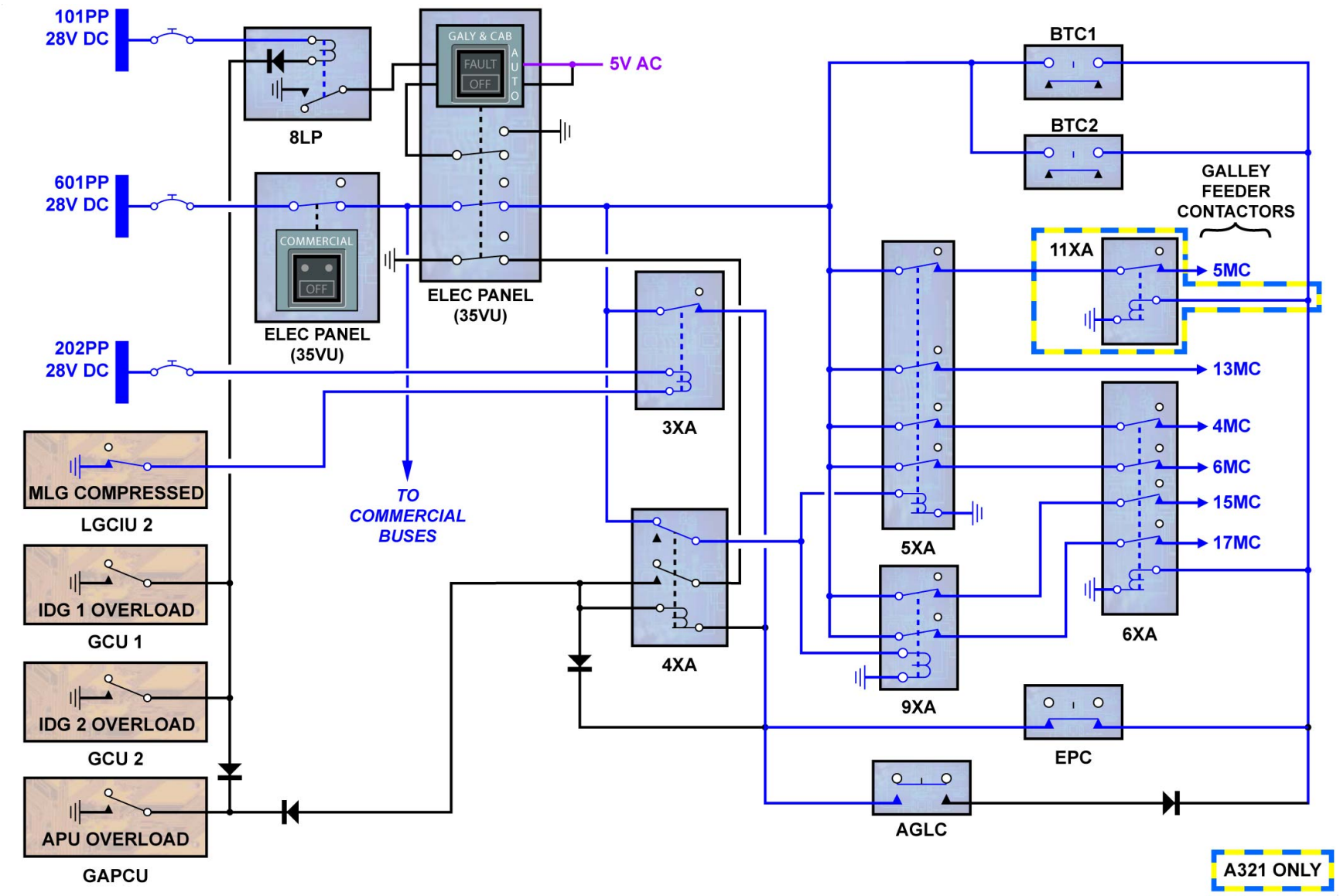
GROUND CONFIGURATION

On ground primary galley power can be supplied from the APU generator only.
On ground primary galley power can be supplied from external power only.



OPERATION - GROUND CONFIGURATION

UGB13131 - U7ST0M0 - UM24DD000000002



OPERATION - GROUND CONFIGURATION

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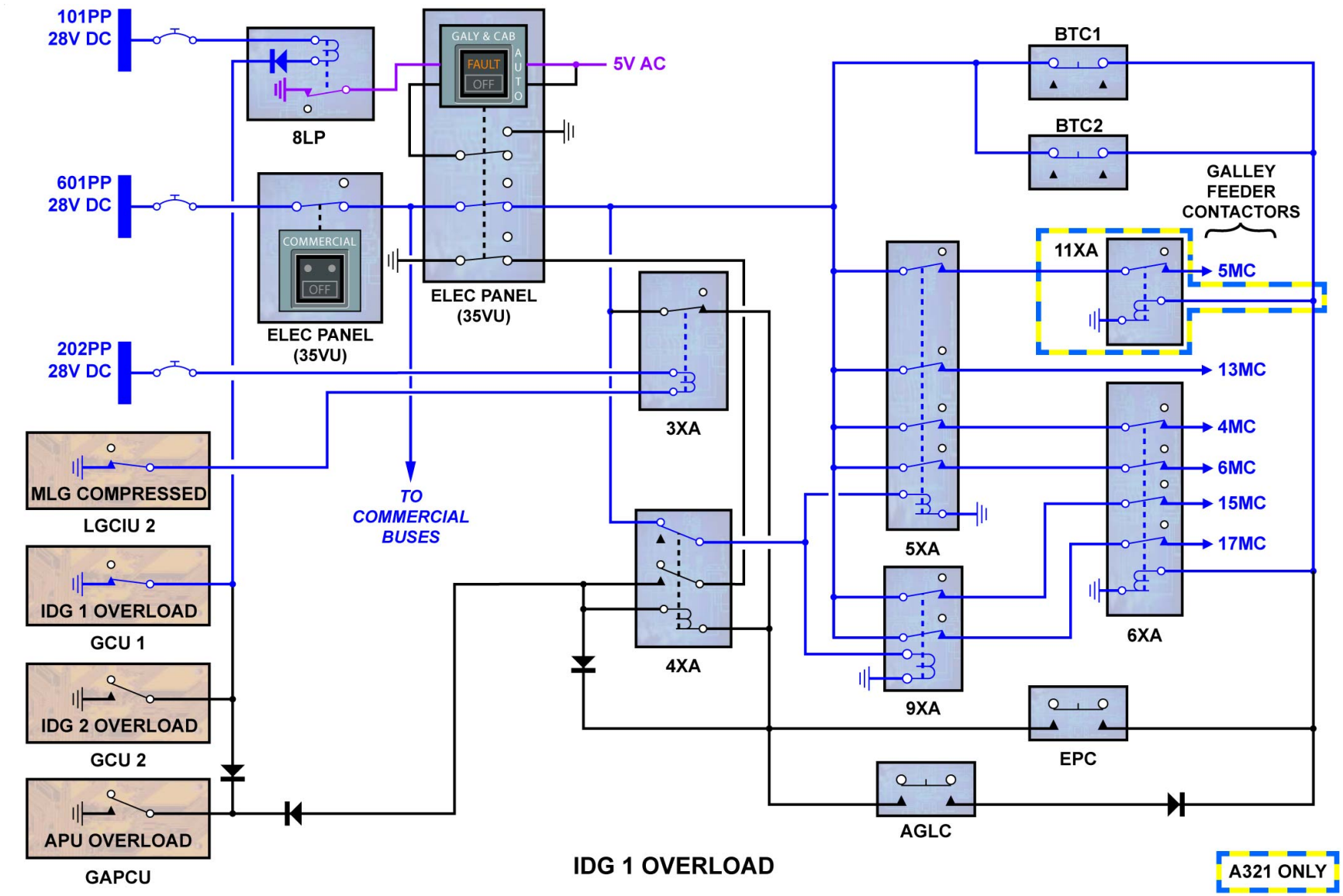
GALLEY SUPPLY D/O (3)

LOAD MONITORING

The GALY & CAB P/BSW FAULT light comes on if a Generator Control Unit (GCU) detects an IDG overload or the GAPCU detects an APU generator overload. An IDG overload does not automatically shed galley power, but an ECAM message is triggered. Switch off the galley power manually to unload the generator. On the ground, an APU generator overload automatically sheds all the galley power.



LOAD MONITORING

UGB13131 - U7ST0M0 - UM24DD000000002

AC GENERATION INTERFACES (3)

COMMUNICATION

The Ground and Auxiliary Power Control Unit (GAPCU) is the interface between the Generator Control Unit (GCU) 1 and 2 and the Centralized Fault Display Interface Unit (CFDIU).

GCU/GAPCU

The GAPCU receives fault data from GCU 1 and 2, on MIL-STD 1553 data links. It transmits the GCU fault data and its own fault data, to the CFDIU, on an ARINC 429 data bus.
For BITE and TEST, the GAPCU and the GCUs can be individually interrogated from the MCDU.
The interface is always through the CFDIU and the GAPCU.

GAPCU/CFDIU

The GAPCU transmits the fault message in clear english language to the CFDIU by ARINC 429 input/output buses (Type 1).
The maintenance test can be performed only on ground with engine shut down. It is initiated either:
- Automatically at each GAPCU power-up.
- Or manually from the MCDU.

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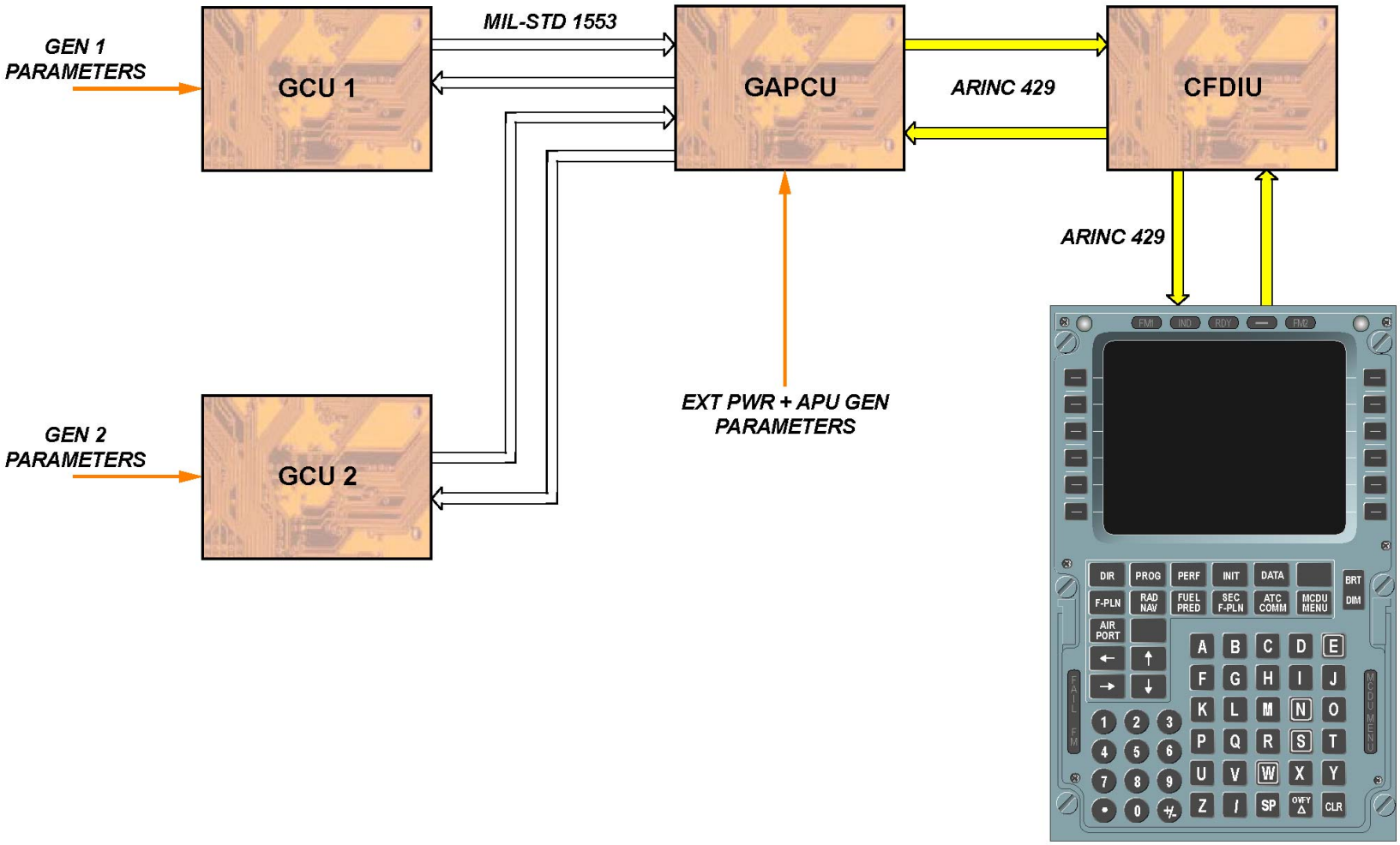


COMMUNICATION ... GAPCU/CFDIU

ELECTRICAL POWER SYSTEM LINE MAINTENANCE (2)

SERVICING

CHECK OF THE OIL LEVEL AND FILTER DPI

Each engine (HP rotor) drives its related Integrated Drive Generator (IDG) through the accessory gearbox.
The drive speed varies according to the engine rating. The IDG internal gearing, converts the variable gearbox frequency to a stable 400 Hz.
The IDG supplies a 115 V AC, 3-phase, and 400 Hz AC. At some point, servicing will be required of the IDG. In this module you will see a video that will demonstrate the correct servicing procedures of the IDG.
Check the oil level and the filter Differential Pressure Indicator (DPI) each 150 Flight Hours (FH) or each time the engine cowls are opened.
Depending on when the time schedule occurs there might be a reason, during transit checks, that you must check the oil level and the filter DPI each 150 FH or each time the engine cowls are opened.
On each engine, use the sight glass that is in the vertical position to do the check of the oil level. If it is below the green band or above the yellow band, do the oil servicing.
Clogged filter indication is provided by a visual pop out indicator (the DPI) mounted on the IDG. This indicator is installed opposite the drive end of the IDG.

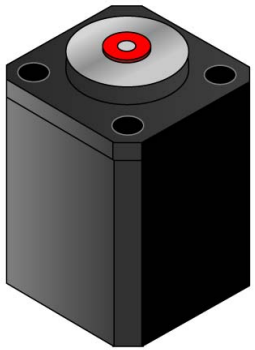
UGB13131 - U7ST0M0 - UM24BA000000002

WARNING

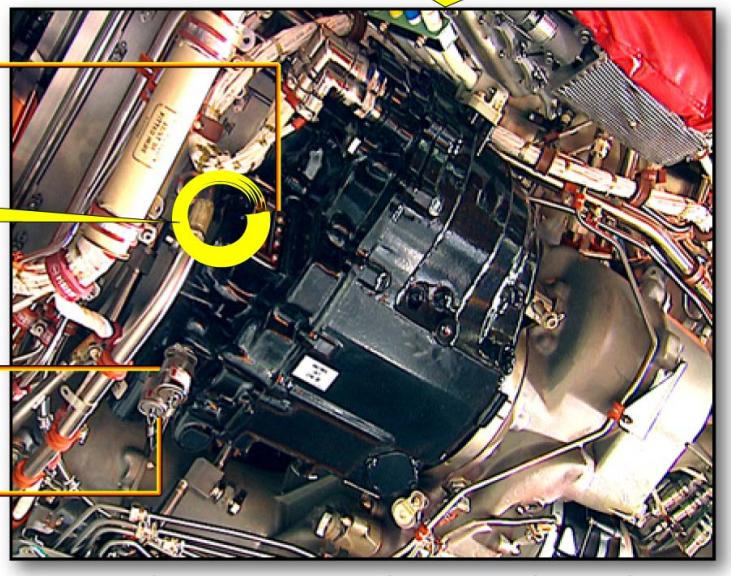
THE ENGINE COMPONENTS CAN STAY HOT.
HANDLE FLUIDS WITH CARE.

CFM 56 engine views taken as exemple.
Identical on PW 6000 and IAE V2500 engines.

CFM 56



DIFFERENTIAL PRESSURE INDICATOR (DPI)



INTEGRATED DRIVE GENERATOR (IDG)

SERVICING - CHECK OF THE OIL LEVEL AND FILTER DPI

ELECTRICAL POWER SYSTEM LINE MAINTENANCE (2)

SERVICING (continued)

OPERATIONAL TEST OF THE IDG DISCONNECT AND RECONNECT FUNCTION

The IDG will be disconnected in case of:
- oil overheat (high oil out temperature),
- oil pressure drop when not caused by drive under speed.

The amber FAULT legend of the ELECtrical/IDG1 or 2 P/BSW comes on, the master warning system is triggered.
In this case, the IDG must be disconnected manually. For this, the PUSH-TO-DISConnect IDG1 (2) safety guarded P/BSW, installed on the panel 35 VU, must be pushed.

CAUTION: ENGAGE THE IDG DISCONNECT MECHANISM WITH THE DISCONNECT RESET RING BEFORE YOU START THE ENGINE. IF NOT, YOU WILL CAUSE DAMAGE TO THE GEAR TEETH, AT ENGINE START.
YOU CAN DAMAGE THE DISCONNECT SOLENOID BECAUSE OF OVERHEATING IF: YOU PUSH THE IDG DISCONNECT P/BSW FOR MORE THAN 3 SECONDS. THERE MUST BE AT LEAST 60 SECONDS BETWEEN 2 OPERATIONS OF THE SWITCH.

On the ELEC control panel, push the IDG 1 (2) P/BSW.
On the IDG 1 (2), slowly pull out the disconnect reset ring to the full limit of travel. If you feel a click while you hold the disconnect reset ring, this shows that the disconnect function operates correctly. Let the disconnect reset ring go slowly back to the initial position.

NOTE: The IDG disconnection is irreversible in flight. Reconnection of the system is then possible only on the ground with engines shut down.

FILLING OF THE IDG WITH OIL OR ADDITION OF OIL

CAUTION: USE ONLY NEW CANS OF OIL WHEN YOU FILL THE IDG WITH OIL OR ADD OIL TO THE IDG. THE CONTAMINATION IN THE OIL RAPID DETERIORATION OF THE OIL AND WILL DECREASE THE LIFE OF THE IDG.

Make the thrust reverser unserviceable,
Depressurize the IDG case,

CAUTION: USE ONLY APPROVED TYPES/BRANDS OF LUBRICANTS. DO NOT MIX TYPES/BRANDS OF LUBRICANTS.

Fill the IDG with filtered oils at a maximum pressure of 35 PSI (2.4131 bar),
Inspect the oil level before and after the related engine start. Inspect the oil level after it becomes stable (5 minutes after running),
If the oil level is at or near the top of the green band, oil servicing is not necessary. If the oil level is below the green band or above the yellow band, servicing is necessary.

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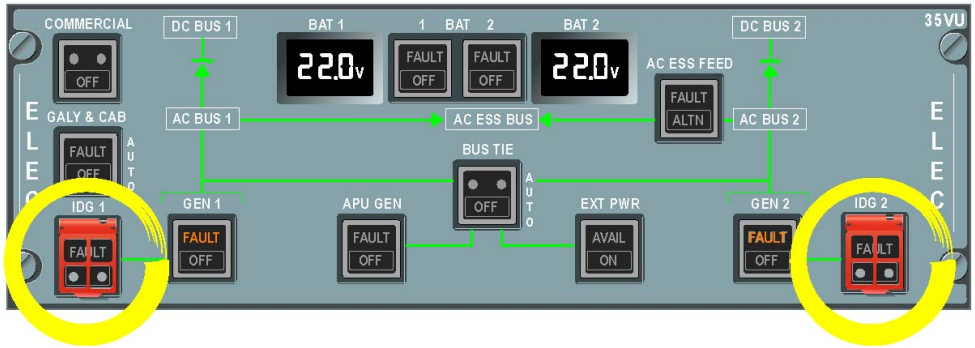
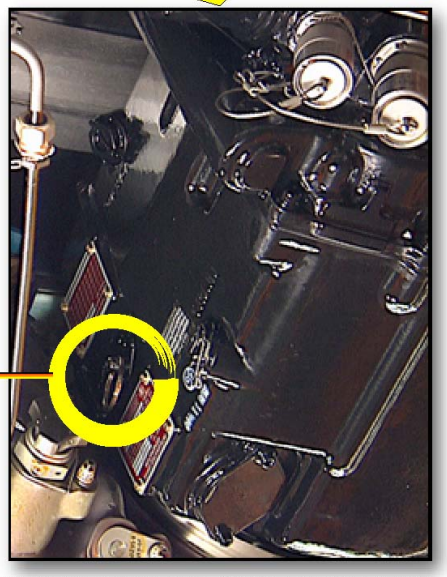
ELECTRICAL CONTROL PANEL (35VU)



CFM 56



INTEGRATED DRIVE GENERATOR (IDG)

DISCONNECT RESET RING

CFM 56 engine views taken as exemple. Identical on PW 6000 and IAE V2500 engines.

CAUTION

ENGAGE THE IDG DISCONNECT MECHANISM WITH THE DISCONNECT RESET RING BEFORE YOU START THE ENGINE. IF NOT, YOU WILL CAUSE DAMAGE TO THE GEAR TEETH, AT ENGINE START.

CAUTION

YOU CAN DAMAGE THE DISCONNECT SOLENOID BECAUSE OF OVERHEATING IF: YOU PUSH THE IDG DISCONNECT P/BSW FOR MORE THAN 3 SECONDS. THERE MUST BE AT LEAST 60 SECONDS BETWEEN 2 OPERATIONS OF THE SWITCH.

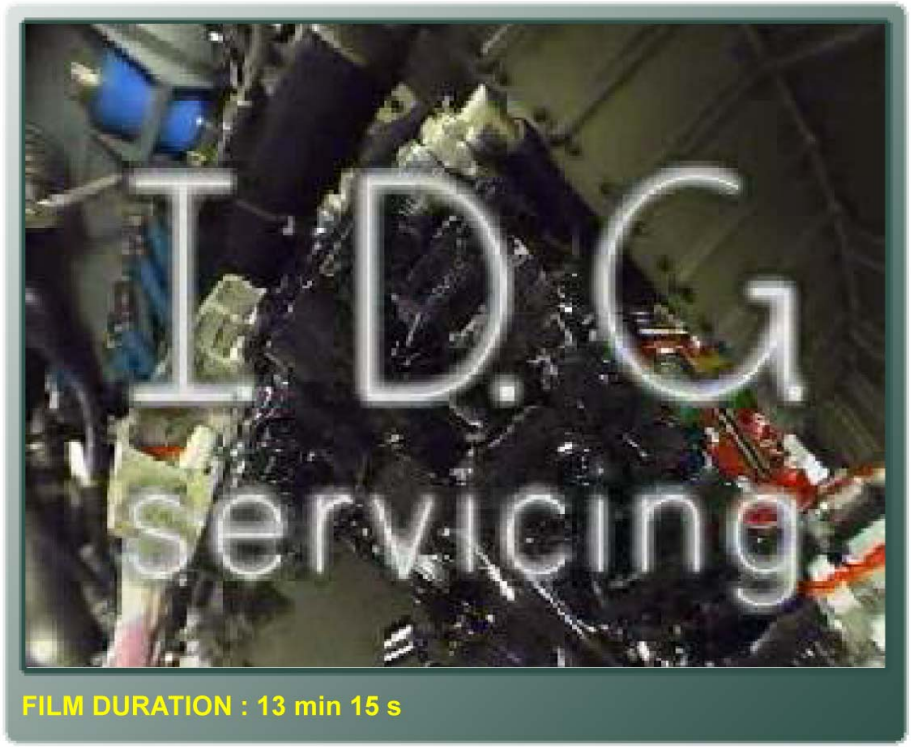
ELECTRICAL POWER SYSTEM LINE MAINTENANCE (2)

SERVICING (continued)

IDG VIDEO

The video shows the servicing of the IDG.

UGB13131 - U7ST0M0 - UM24BA000000002



SERVICING - IDG VIDEO

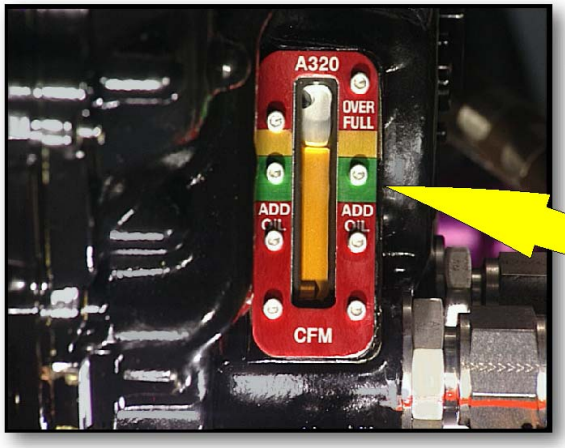
ELECTRICAL POWER SYSTEM LINE MAINTENANCE (2)

MAINTENANCE TIPS

It must be mentioned here that the most typical reason for IDG failures are due to over servicing. You must pay particular attention to the level of the oil in the sight glass.
When servicing, leave the drain hose attached until only a couple of drops come out.

- Pay particular attention to the level of the oil in the sight glass.

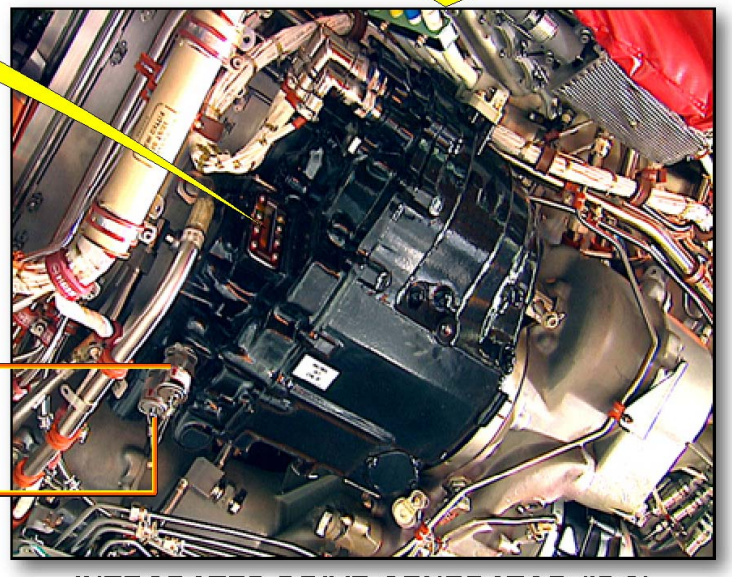
CFM 56 engine views taken as exemple. Identical on PW 6000 and IAE V2500 engines.



SIGHT GLASS

CFM 56

- Leave the drain hose attached to the oil overflow plug until a couple of drops come out.



INTEGRATED DRIVE GENERATOR (IDG)

MAINTENANCE TIPS

IDG REMOVAL AND INSTALLATION (3)

IDG REMOVAL

Before removing the IDG the engine must be shutdown for at least 5 minutes to prevent burns because the oil stays hot for a few minutes. First of all, the IDG must be drained and the oil tube disconnected and removed. Also remove the banjo couplings and note their initial position, then disconnect the three electrical connectors from the IDG. Remove the cover plate of the IDG terminal box and disconnect the output cables. Next, place the special dolly in position and raise it up to the IDG. When the IDG is on the dolly release the Quick Attach/Detach coupling, then pull the IDG forward to disengage it.

NOTE: Refer to your Aircraft Maintenance Manual when performing this operation. This film is made on IAE engine but the procedure is similar on CFM and PW engines.

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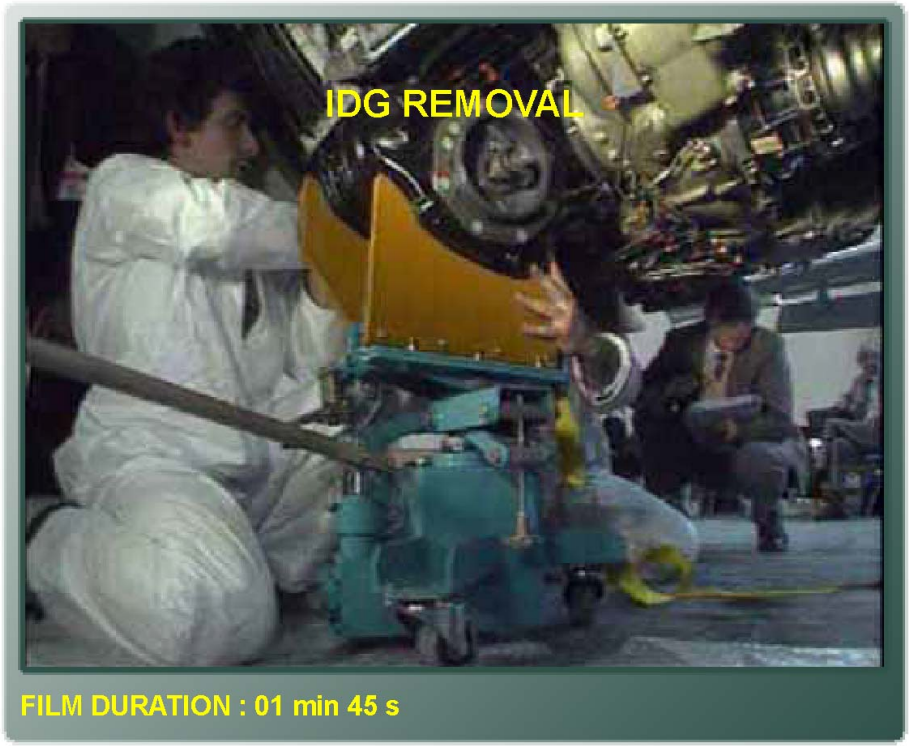

IDG REMOVAL

IDG REMOVAL AND INSTALLATION (3)

IDG INSTALLATION

Using the dolly, lift the IDG up to its position and align the open marks on the Quick Attach/Detach coupling. When the IDG is engaged tighten the coupling sufficiently to secure it, then remove the dolly, reconnect the electrical connectors and reinstall the oil tubes.

NOTE: Refer to your Aircraft Maintenance Manual when performing this operation. This film is made on IAE engine but the procedure is similar on CFM and PW engines.

UGB13131 - U7ST0M0 - UM24Y3000000001

IDG INSTALLATION

AC EMERGENCY GENERATION D/O (3)

GENERATOR

The Constant Speed Motor/Generator (CSM/G) has a hydraulic motor, which drives a generator. The hydraulic motor is pressurized by the blue hydraulic system through an integrated solenoid valve. The hydraulic motor speed is regulated by a servo valve. The generator operation principle is identical to that of the main or auxiliary generation. The generator output characteristics are:
- three phase 115/200V AC,
- 400 Hz (12000 rpm),
- output power: 5 kVA continuously.

CSM/G CONTROL UNIT SUPPLY

During transient configuration, battery 2 and then the Permanent Magnet Generator (PMG) supply the CSM/G control unit and the exciter field through a voltage regulation module. The voltage regulation module maintains the Point Of Regulation (POR) at a nominal voltage value (115V AC).

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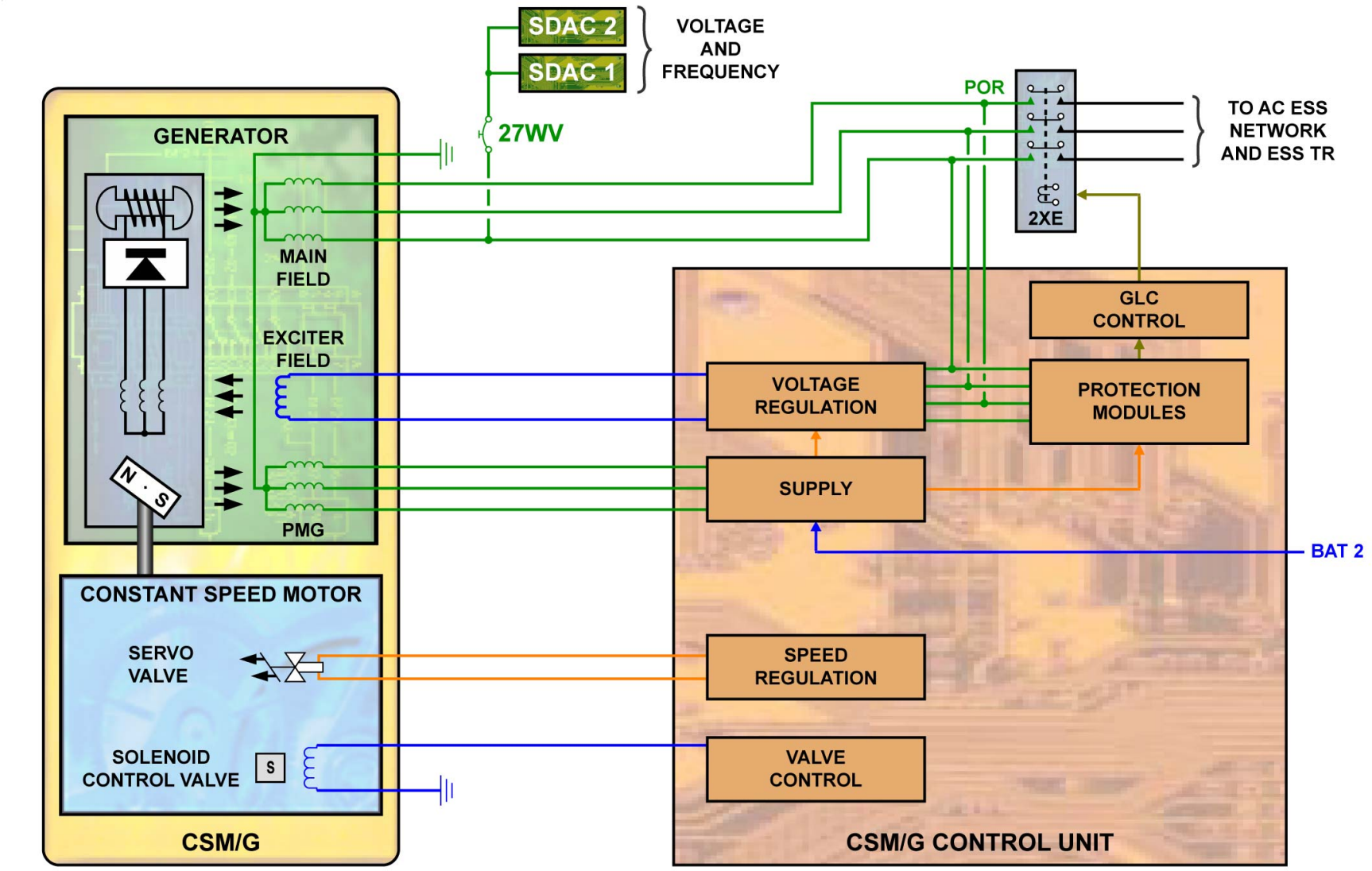


GENERATOR & CSM/G CONTROL UNIT SUPPLY

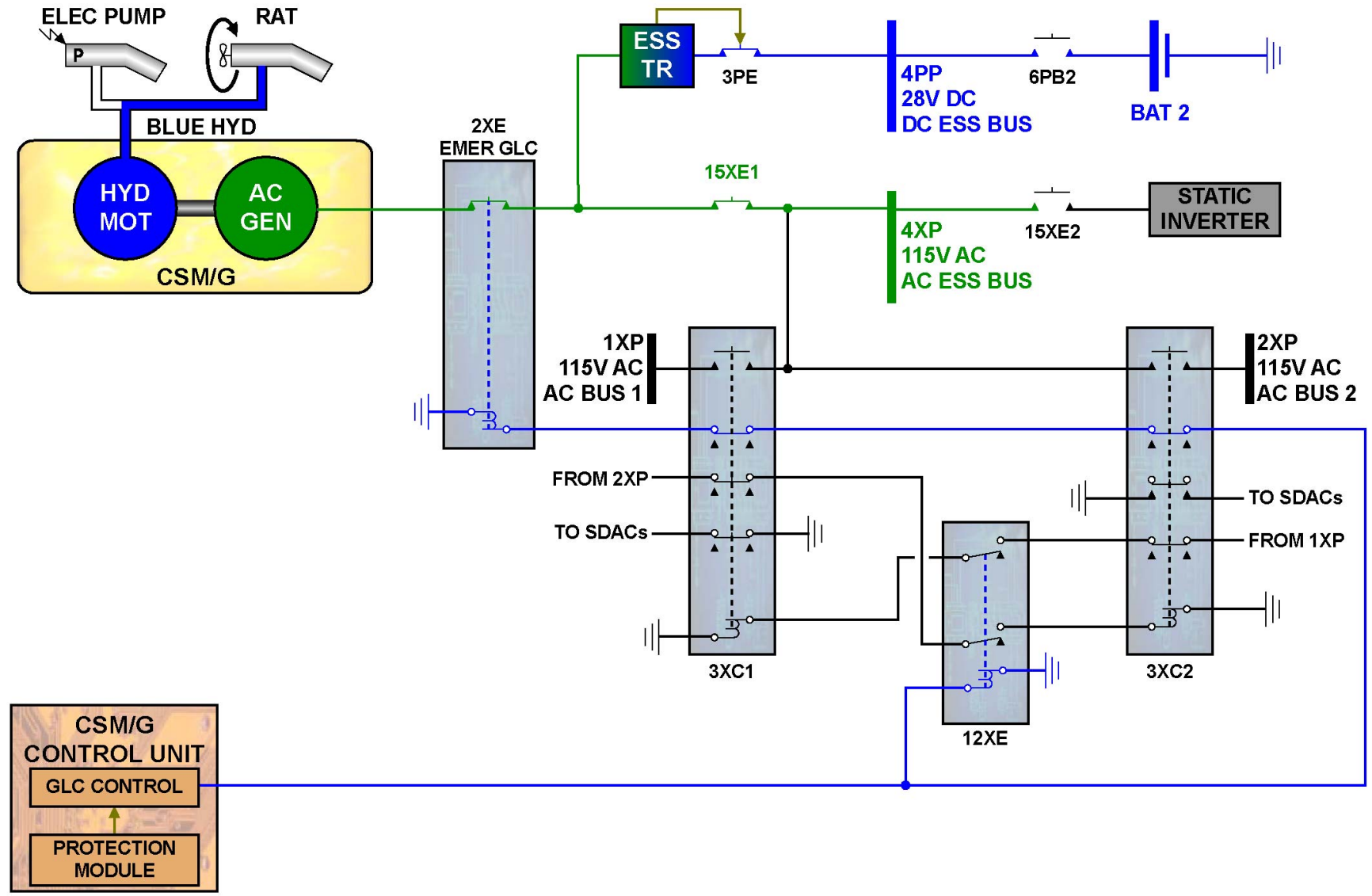
AC EMERGENCY GENERATION D/O (3)

GENERATOR OPERATION CONTROL

As the emergency AC generator parameters are correct, the emergency Generator Line Contactor (GLC) is supplied by the CSM/G control unit. The emergency AC generator has priority to supply the AC and DC ESSential BUSes: contactors 3XC1 and 3XC2 are de-energized by relay 12XE.

NOTE: The diagram shows the system in emergency configuration (relays 1XP & 2XP de-energized, busbars 4PP & 4XP energized).

UGB13131 - U7ST0M0 - UM24DH000000001



GENERATOR OPERATION CONTROL

AC EMERGENCY GENERATION D/O (3)

GENERATOR MONITORING

The CSM/G operation is monitored by a red FAULT light. The FAULT light activation is controlled by either Battery Charge Limiter (BCL) 1 or 2. During transient configuration, or if the generator is faulty, there is no ESS Transformer Rectifier (TR) output, thus the FAULT light comes on.

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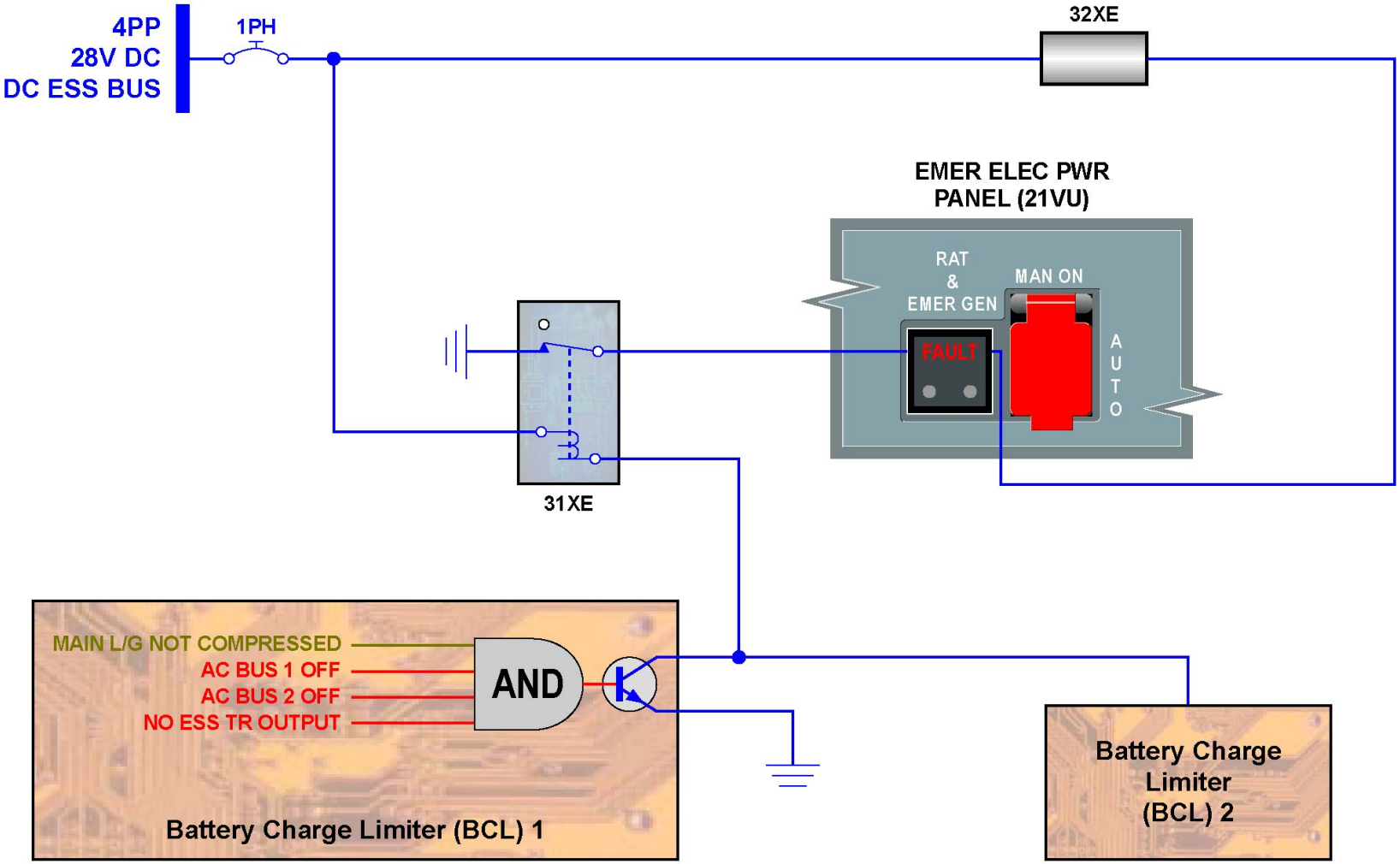

GENERATOR MONITORING

EMER ELECTRICAL POWER LOGIC DESCRIPTION (3)

EMERGENCY GENERATION AUTOMATIC OPERATION

If AC BUS 1 and 2 are lost above a given airspeed (100 kts), the Ram Air Turbine (RAT) will extend automatically. As the AC generator is not yet available, the AC ESSential BUS and DC ESS BUS are respectively supplied by the STATic INVerter and battery 2. The activation of the emergency generator via the blue hydraulic system takes place only if the landing gear is not compressed. When the emergency generator is available, it supplies the AC ESS BUS and via ESS Transformer Rectifier (TR), the DC ESS BUS. As the nose landing gear is compressed, the AC ESS BUS and DC ESS BUS are respectively supplied by the STAT INV and the battery 2.

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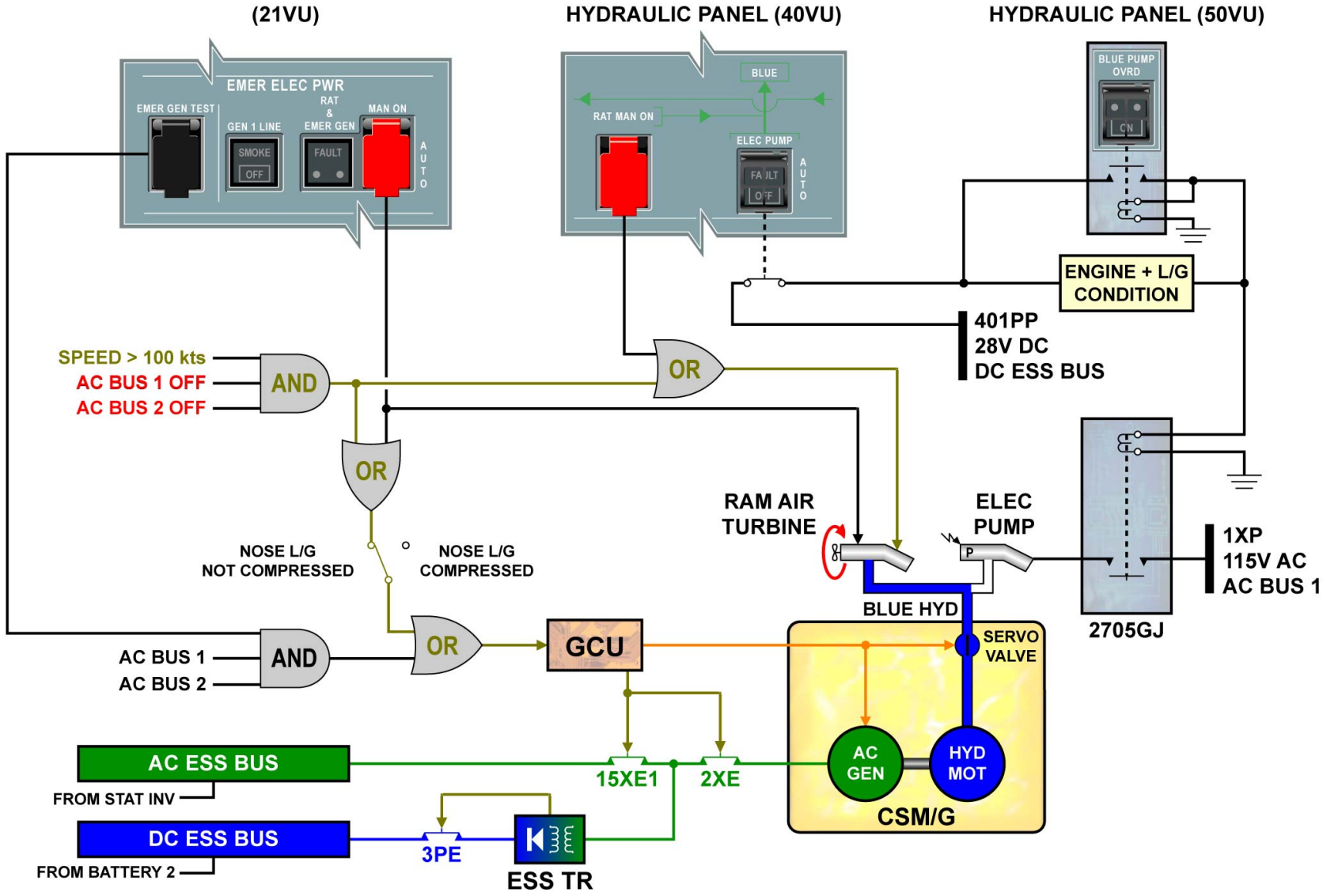


EMERGENCY GENERATION AUTOMATIC OPERATION

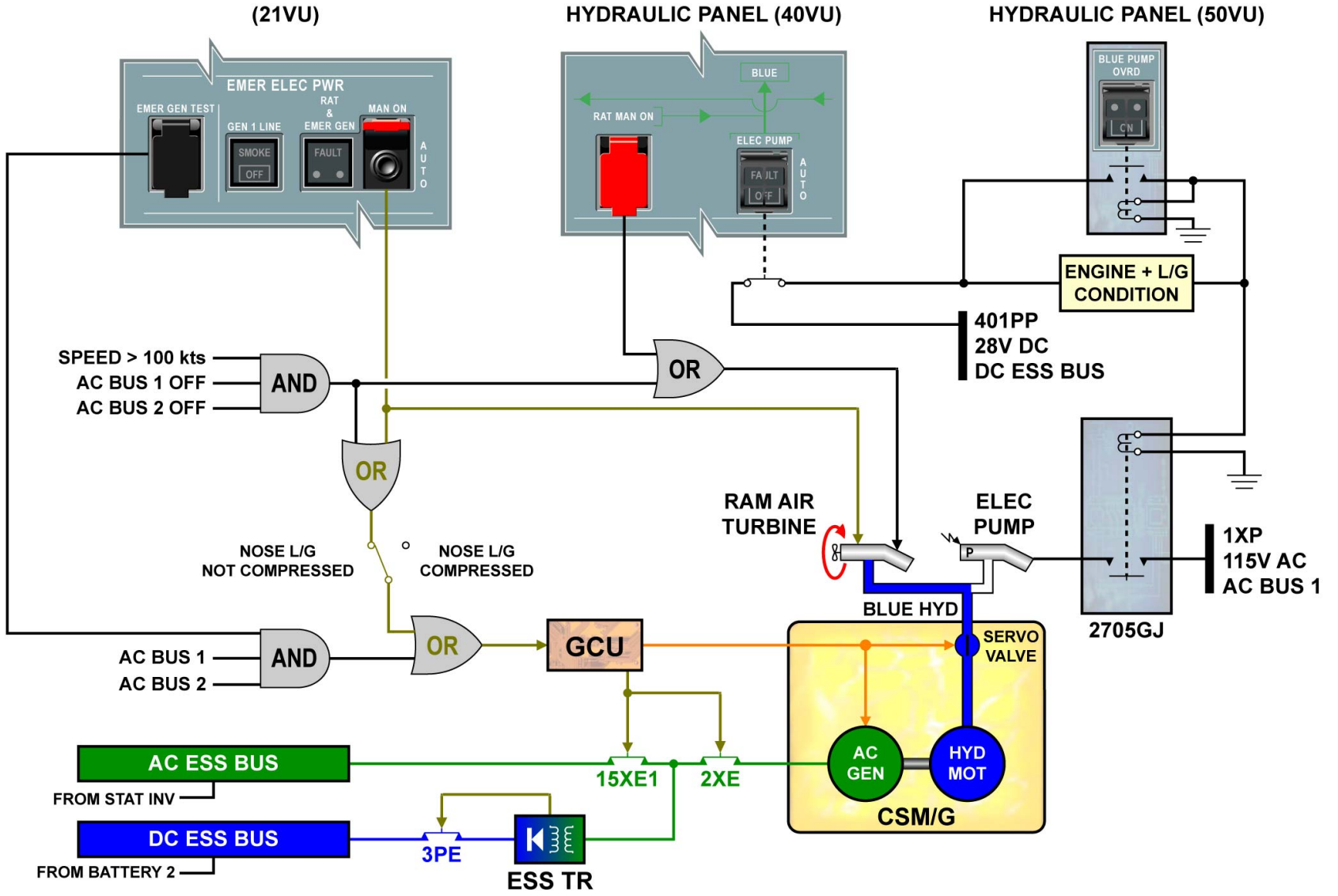
UGB13131 - U7ST0M0 - UM24DI000000001

EMER ELECTRICAL POWER LOGIC DESCRIPTION (3)

EMERGENCY GENERATION MANUAL OPERATION IN FLIGHT

If AC BUS 1 and 2 are lost and the RAT does not extend, FAULT light comes on red on the EMERgency ELECtrical PoWeR panel. The RAT must be manually extended to power the emergency generator. This is done by pressing the guarded MANual ON P/BSW on the EMER ELEC PWR panel.

UGB13131 - U7ST0M0 - UM24DI000000001



EMERGENCY GENERATION MANUAL OPERATION IN FLIGHT

EMER ELECTRICAL POWER LOGIC DESCRIPTION (3)

EMERGENCY GENERATION MANUAL OPERATION ON GROUND

WARNING: If the MAN ON P/BSW is pressed in, the RAT extends, even in cold aircraft configuration.

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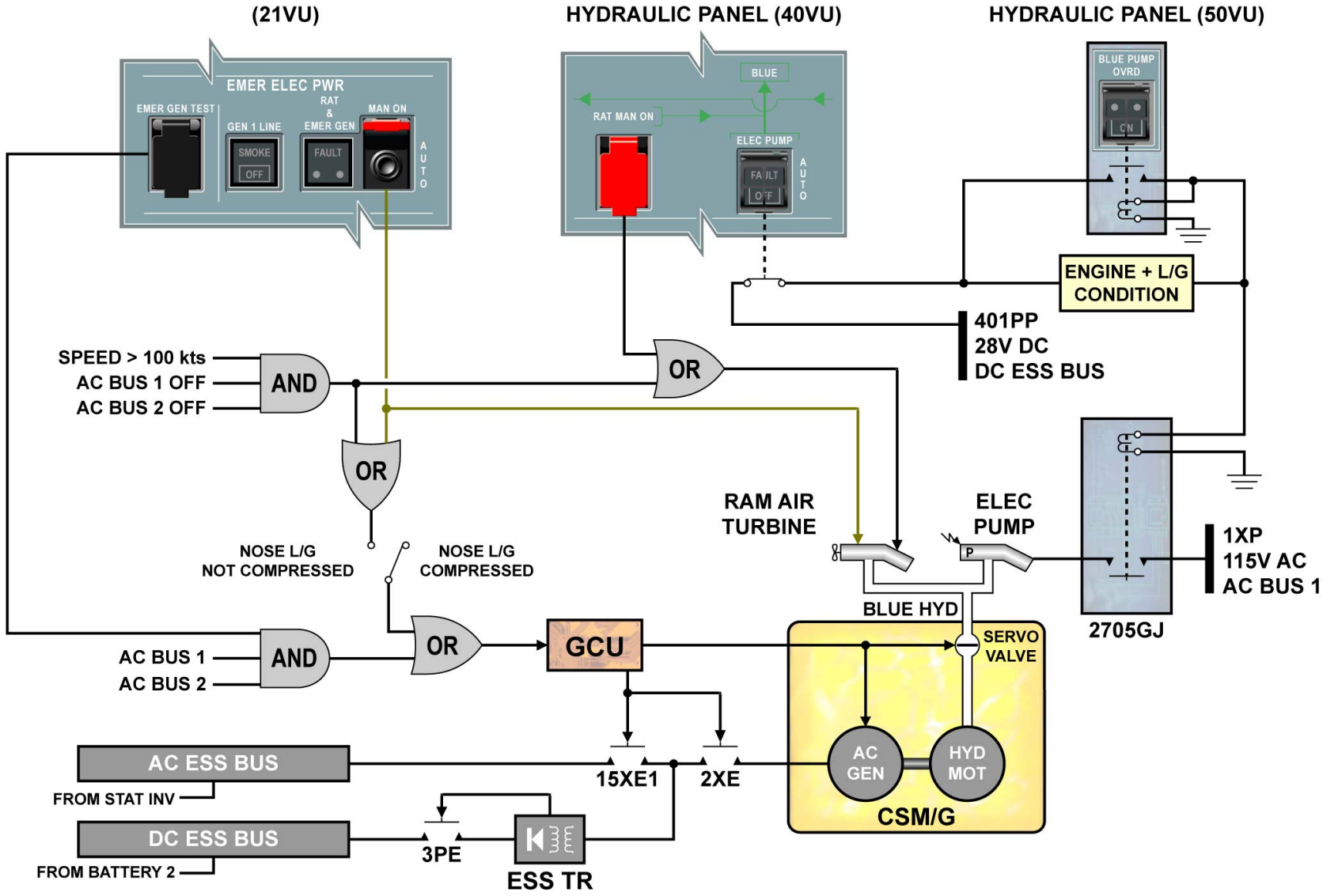

EMERGENCY GENERATION MANUAL OPERATION ON GROUND

EMER ELECTRICAL POWER LOGIC DESCRIPTION (3)

EMERGENCY GENERATION TEST

The emergency generator operational test is carried out to check the emergency generator parameters and the corresponding network supply. For test purposes the blue hydraulic system must be pressurized thanks to the BLUE PUMP OVerRiDe P/BSW and the EMER GEN TEST P/BSW must be held pressed in. As the emergency generator is connected, the generator parameters have to be checked on the ECAM display.

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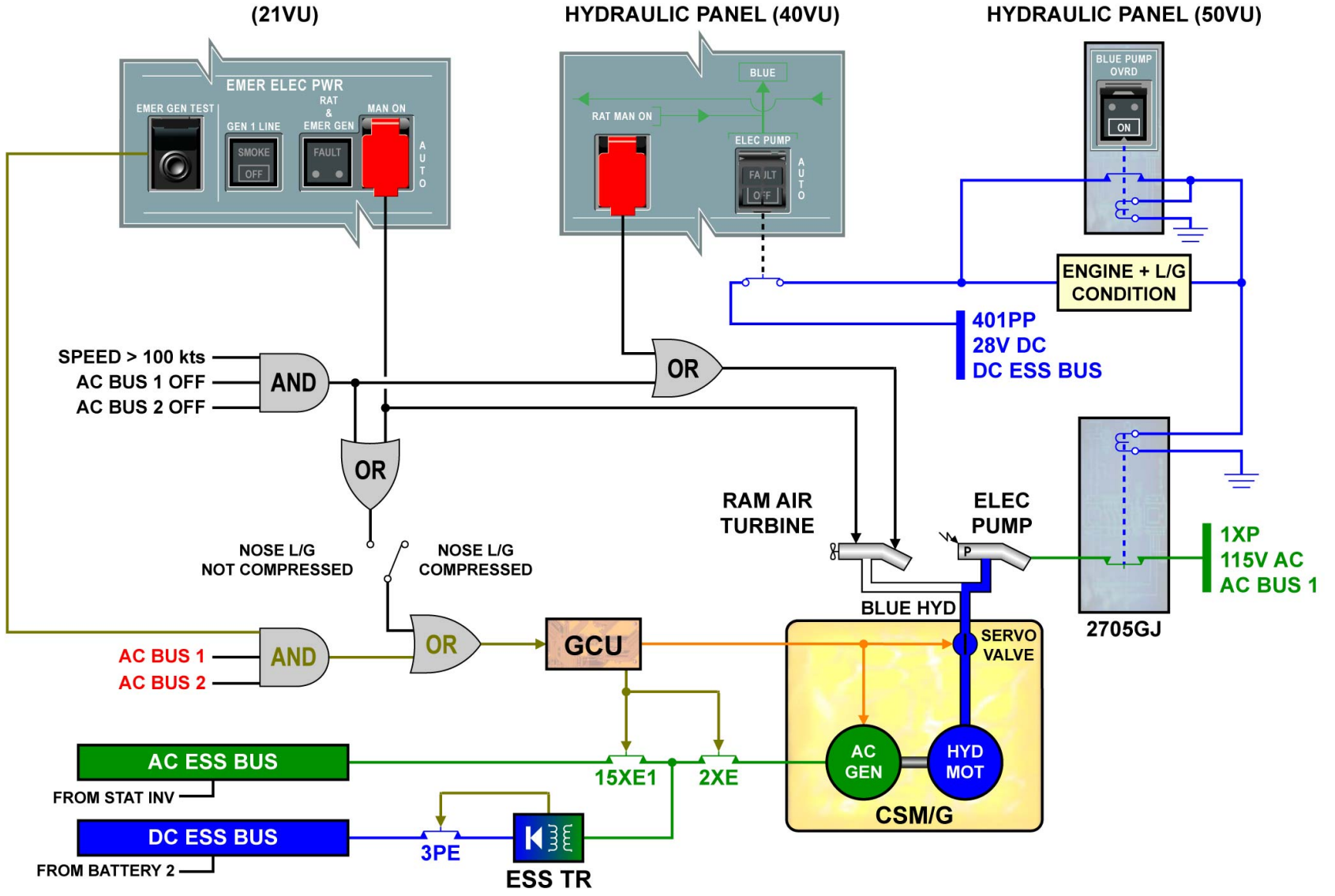

EMERGENCY GENERATION TEST

RAT ACTIVATION (3)

AUTOMATIC ACTIVATION

When one of the two main AC buses is supplied, relay 17XE or 18XE is energized. This prevents an automatic deployment of the Ram Air Turbine (RAT).
In flight, when there is a total failure of the two AC main buses and when the aircraft speed is higher than 100 kts, the two relays 17XE and 18XE are de-energized, which supplies relay 20XE with +28VDC from the hot battery bus 703PP.
Relay 20XE is then energized after 1 second.and +28VDC are supplied from the Hot Battery Bus to the RAT solenoid 1 and the Constant Speed Motor Generator (CSM/G) Generator Control Unit (GCU) through the de-energized contacts of relay 22XE.
The RAT extends automatically. The Constant Speed Motor/Generator (CSM/G) control unit activates the CSM/G solenoid valve and uses battery 2 for the supply voltage. The generator starts to operate.
After 6 seconds, relay 22XE closes its contacts. The RAT solenoid 1 is de-energized and the control supply voltage of the CSM/G solenoid valve is switched from Battery 2 to the Permanent Magnet Generator (PMG) of the CSM/G.

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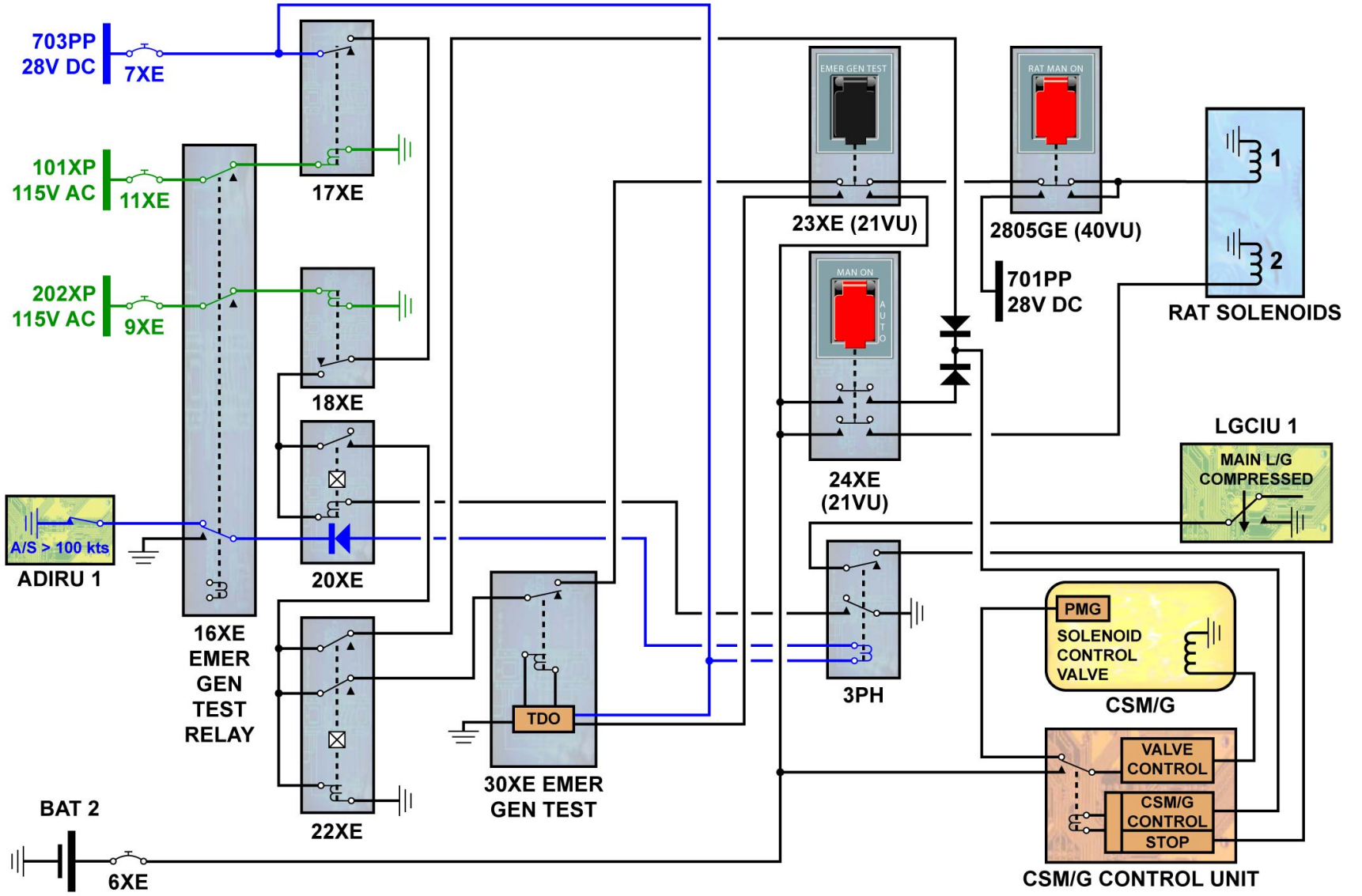
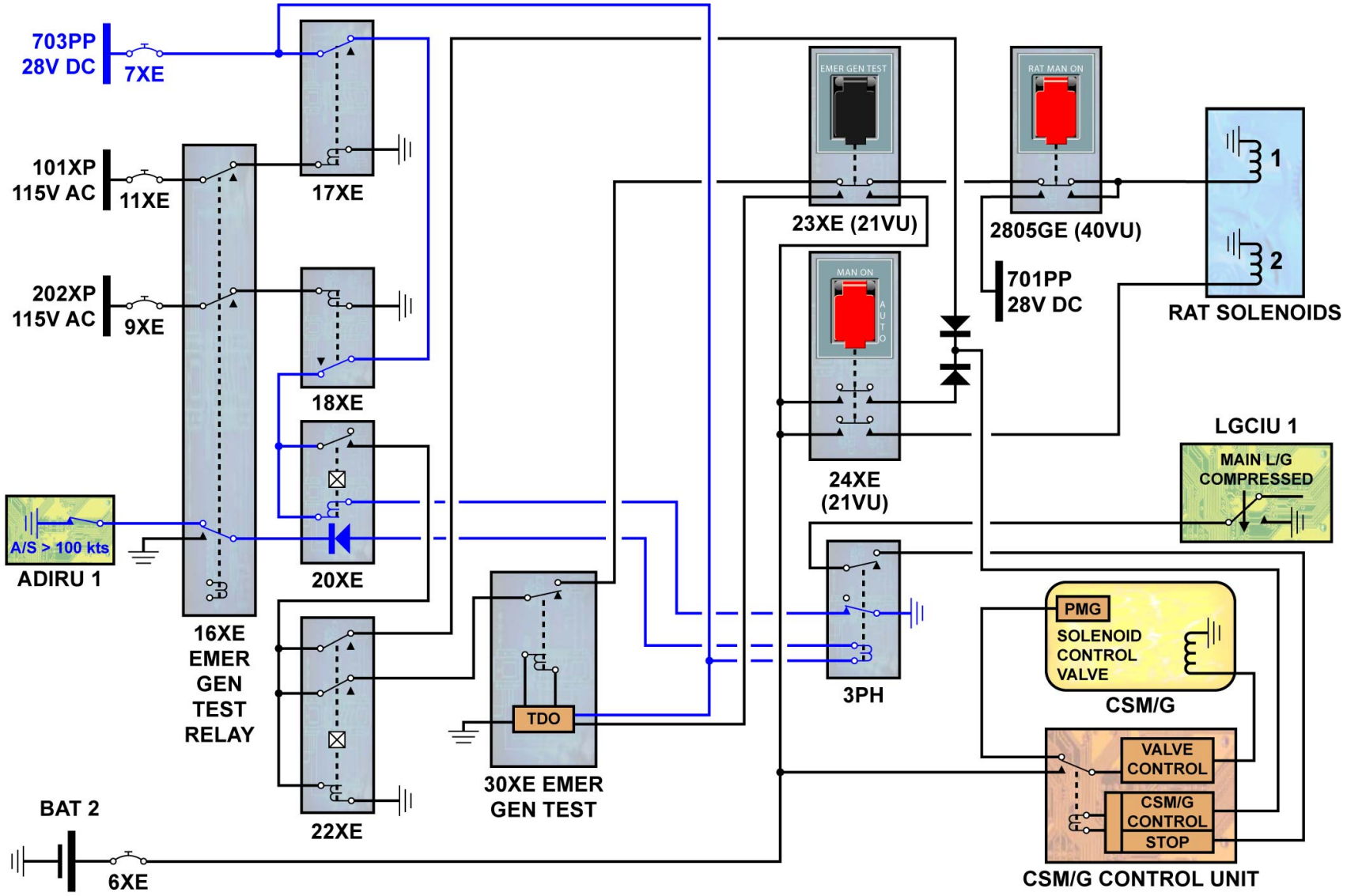
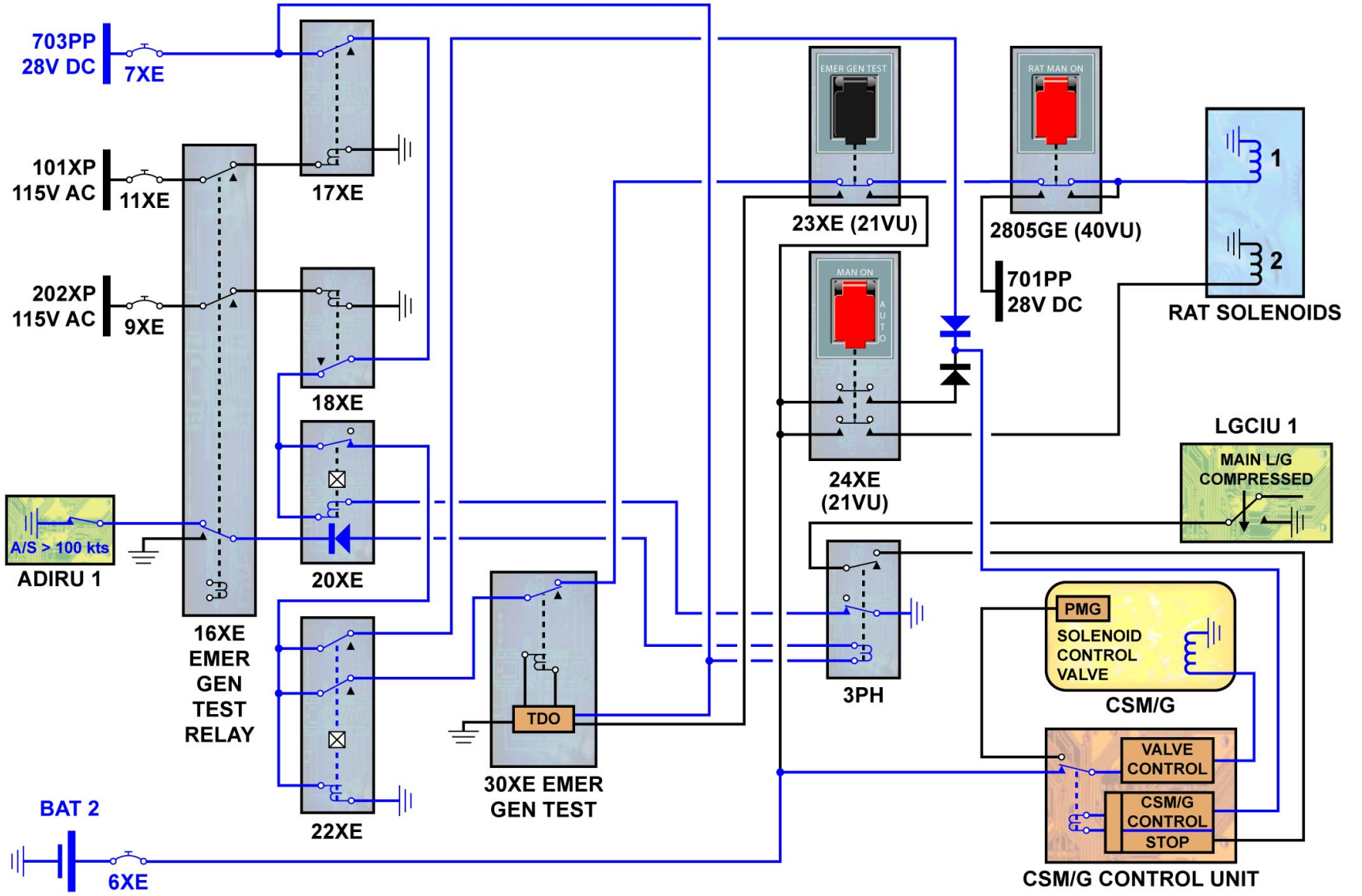


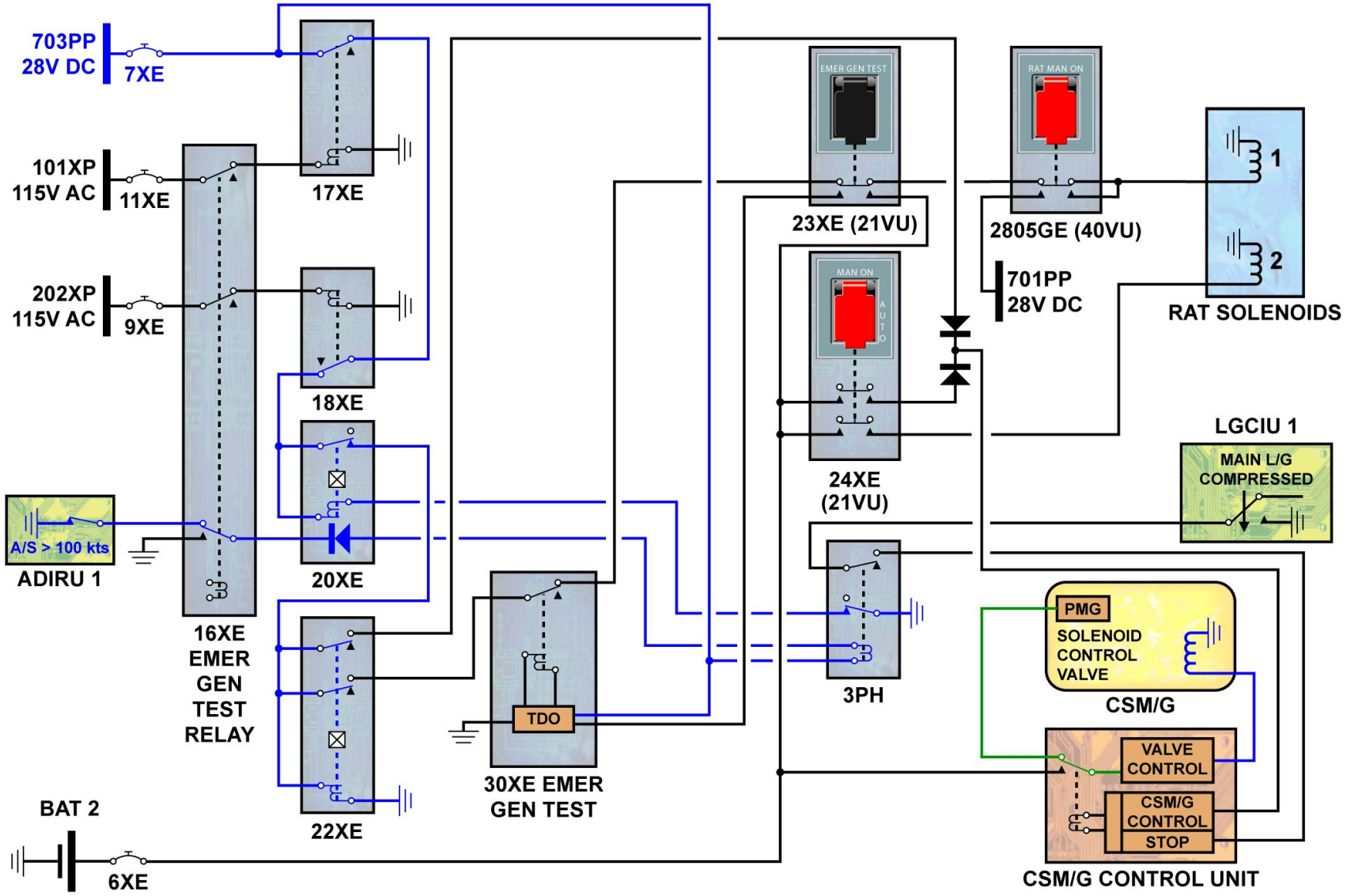
AUTOMATIC ACTIVATION



AUTOMATIC ACTIVATION



AUTOMATIC ACTIVATION



AUTOMATIC ACTIVATION

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UGB13131 - U7ST0M0 - UM24DJ000000001

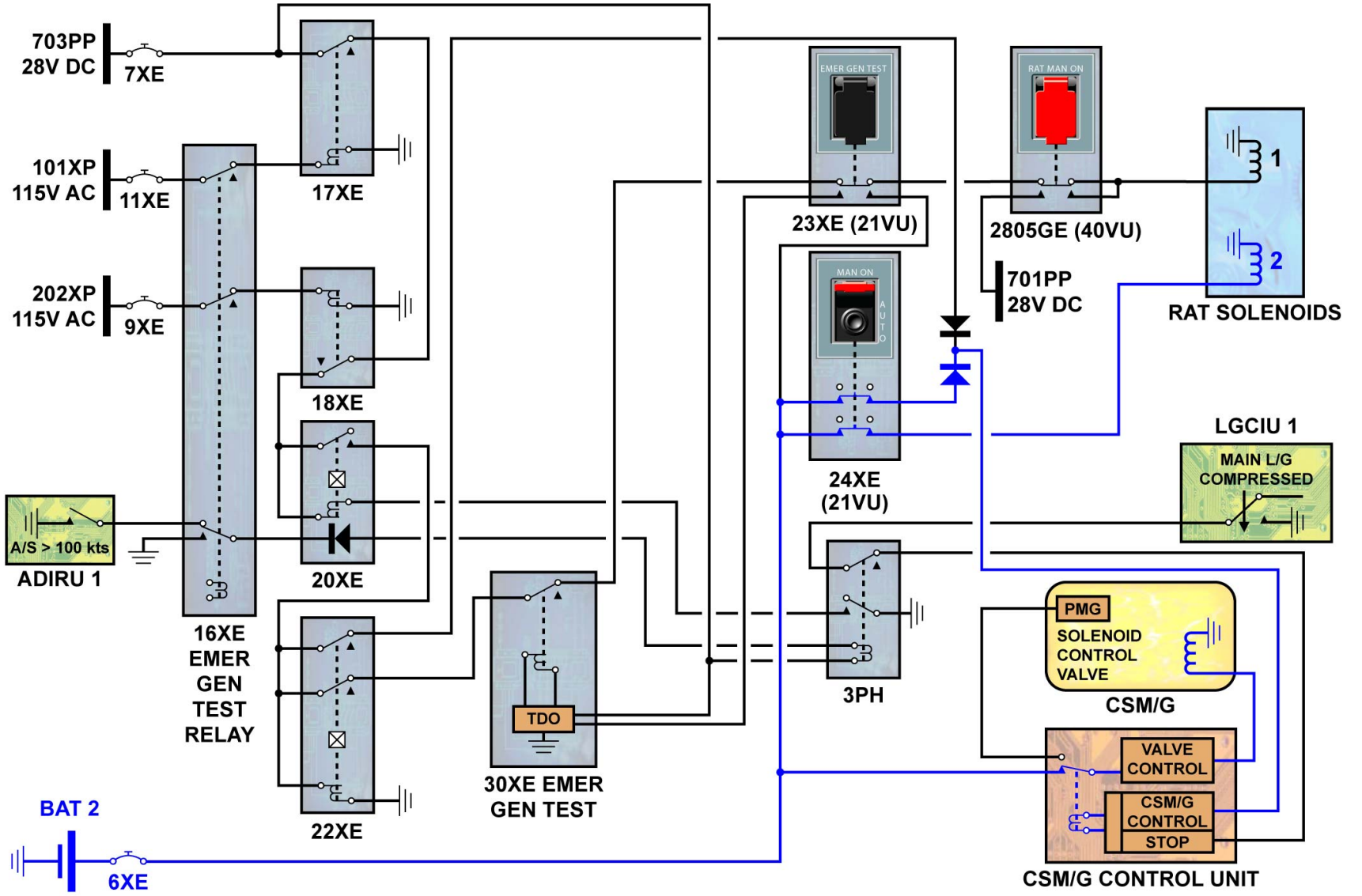
RAT ACTIVATION (3)

MANUAL ACTIVATION

When the MANual ON P/BSW is pressed, RAT solenoid 2 is energized by battery 2 and the RAT extends. In addition, the CSM/G control unit activates the CSM/G solenoid valve using battery 2 and the generator starts running. When the MAN ON P/BSW is released out, RAT solenoid 2 is de-energized. The CSM/G solenoid valve is supplied by PMG.

NOTE: The RAT manual activation function is only used in case of CSM/G automatic control logic failure.
The diagram shows the system with MAN ON P/BSW still pressed in. (RAT solenoid 2 still energized, generator starts running)

UGB13131 - U7ST0M0 - UM24DJ000000001



MANUAL ACTIVATION

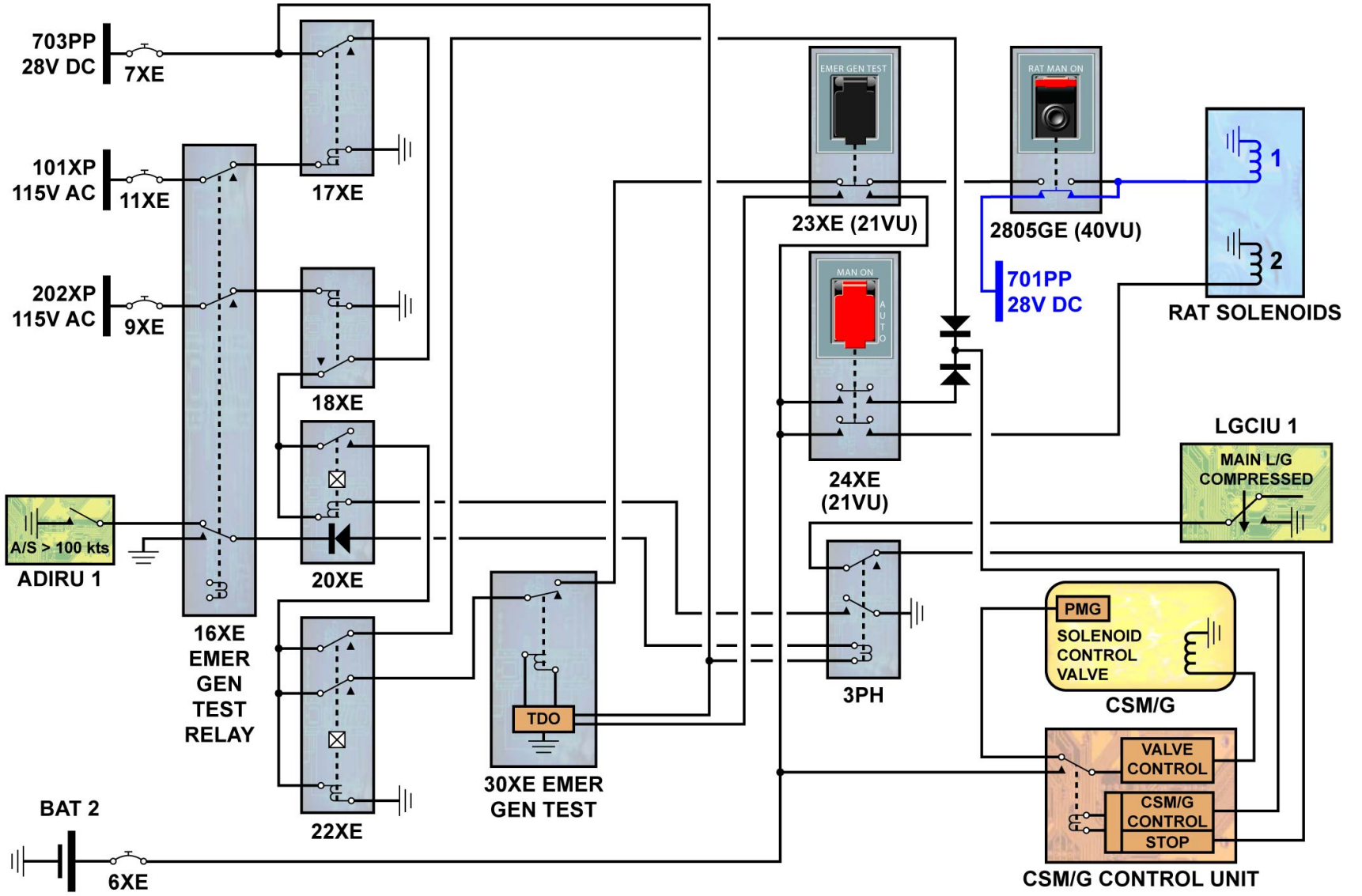
UGB13131 - U7ST0M0 - UM24DJ000000001

RAT ACTIVATION (3)

MANUAL ACTIVATION FROM HYDRAULIC PANEL

The RAT MAN ON P/BSW on the blue hydraulic panel enables the extension of the RAT for hydraulic power supply only. Solenoid 1 is supplied by HOT BAT BUS 1.

UGB13131 - U7ST0M0 - UM24DJ000000001



MANUAL ACTIVATION FROM HYDRAULIC PANEL

UGB13131 - U7ST0M0 - UM24DJ000000001

CSM/G GCU D/O (3)

GENERATOR CONTROL

The automatic control logic being set, the Generator Control Unit (GCU) internal 28V DC bus is supplied by battery 2 through relay K3. Relay K1 is then energized, allowing the solenoid control valve to be supplied by the internal bus (still on battery 2). Relay K3 is held closed by the GCU internal supply via relay K2 and the time delay-opening transistor. When the emergency generator parameters are correct (voltage and frequency above voltage and frequency threshold), or after 10 s equal to the Constant Speed Motor/Generator (CSM/G) start sequence, relay K2 closes. The Generator Line Contactor (GLC) closes and relay K3 is de-energized, allowing the solenoid control valve power supply change over from battery 2 to the Permanent Magnet Generator (PMG). The CSM/G can also be started manually via the MANual ON P/BSW.

SPEED REGULATION

The speed regulation module of the control unit electrically controls the servo-valve, which regulates the hydraulic motor speed. The GCU maintains the CSM/G at constant speed by:
- monitoring the frequency of the PMG,
- and comparing it with a quartz crystal controlled reference.

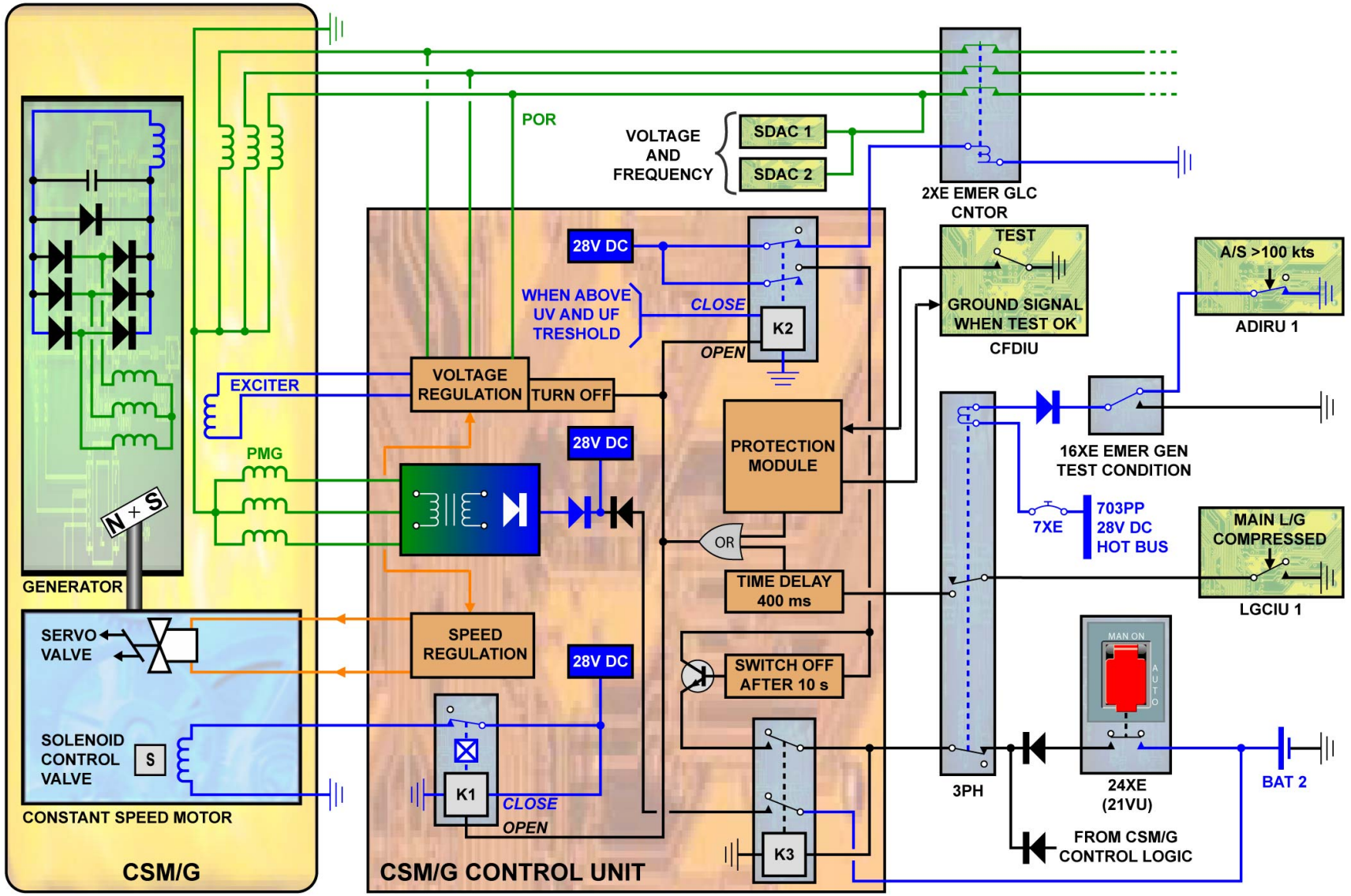
The resulting error signal is then used to control the CSM/G servo-valve to a more open or close position.

VOLTAGE REGULATION

The PMG supplies the exciter field through a voltage regulation module. The GCU maintains the CSM/G output voltage constant by monitoring the voltage at the Point Of Regulation (POR). The output voltage is compared to 115V AC reference and used as an operational error to regulate the field current.

NOTE: The diagram shows the system in normal configuration (K3 de-energized, solenoid control valve supplied by PMG).

UGB13131 - U7ST0M0 - UM24DK000000001



GENERATOR CONTROL ... VOLTAGE REGULATION

CSM/G GCU D/O (3)

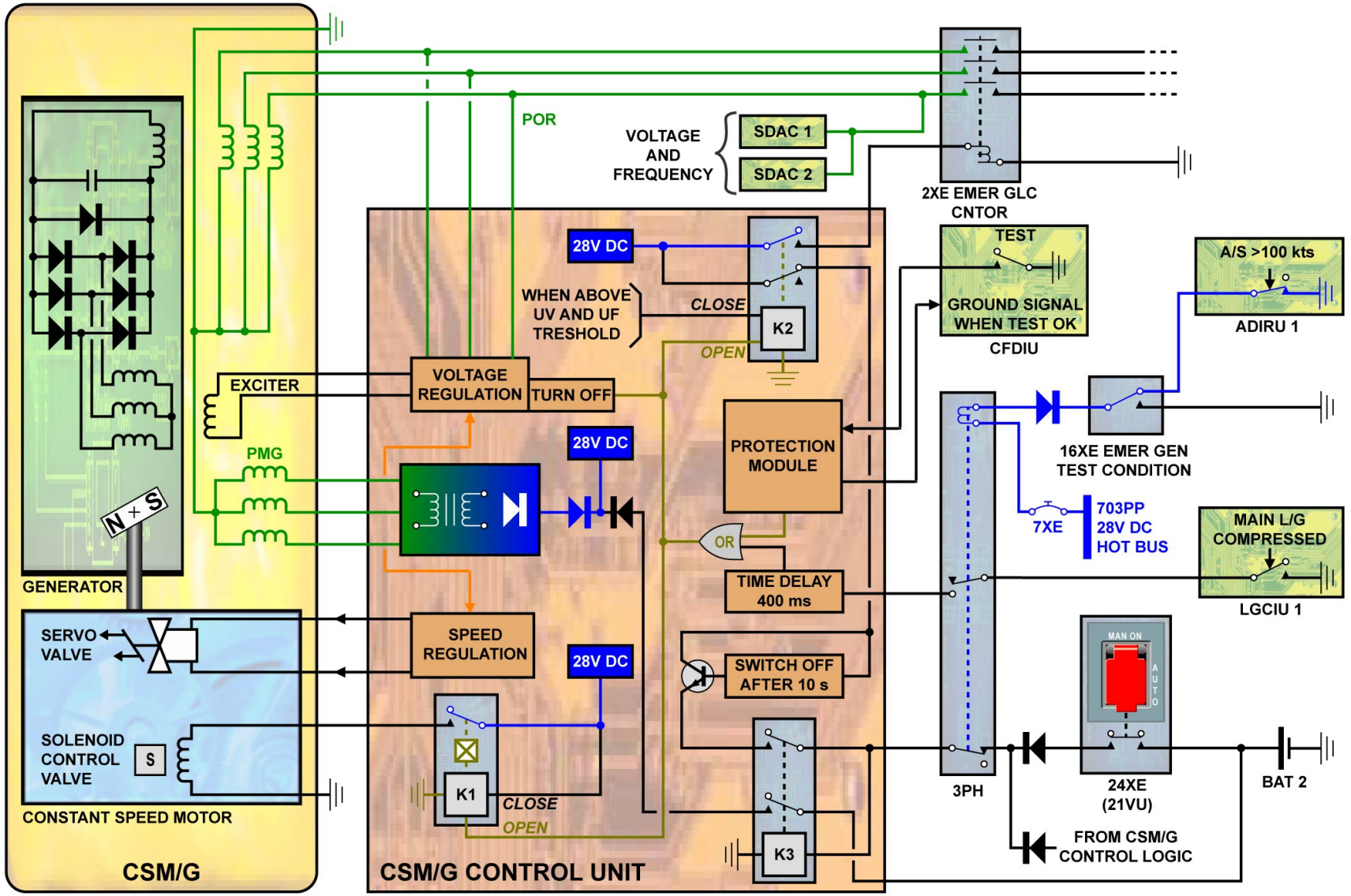
GENERATOR MONITORING

The protection module protects the network and the generator by controlling the related GLC, the generator field current and the solenoid control valve. The protections are the following:
- over/under voltage,
- over/under frequency,
- shorted PMG,
- fast over speed shutdown.

When a failure is detected, relay K1 opens to de-energize the solenoid control valve: The generator stops operating. The MAN ON P/BSW must be pressed in to reset the protection module and to recover the solenoid control valve power supply.

NOTE: The diagram shows the system after fault detection, and before the generator stops (solenoid control valve de-energized). The MAN ON P/BSW is not pressed in yet.

UGB13131 - U7ST0M0 - UM24DK000000001



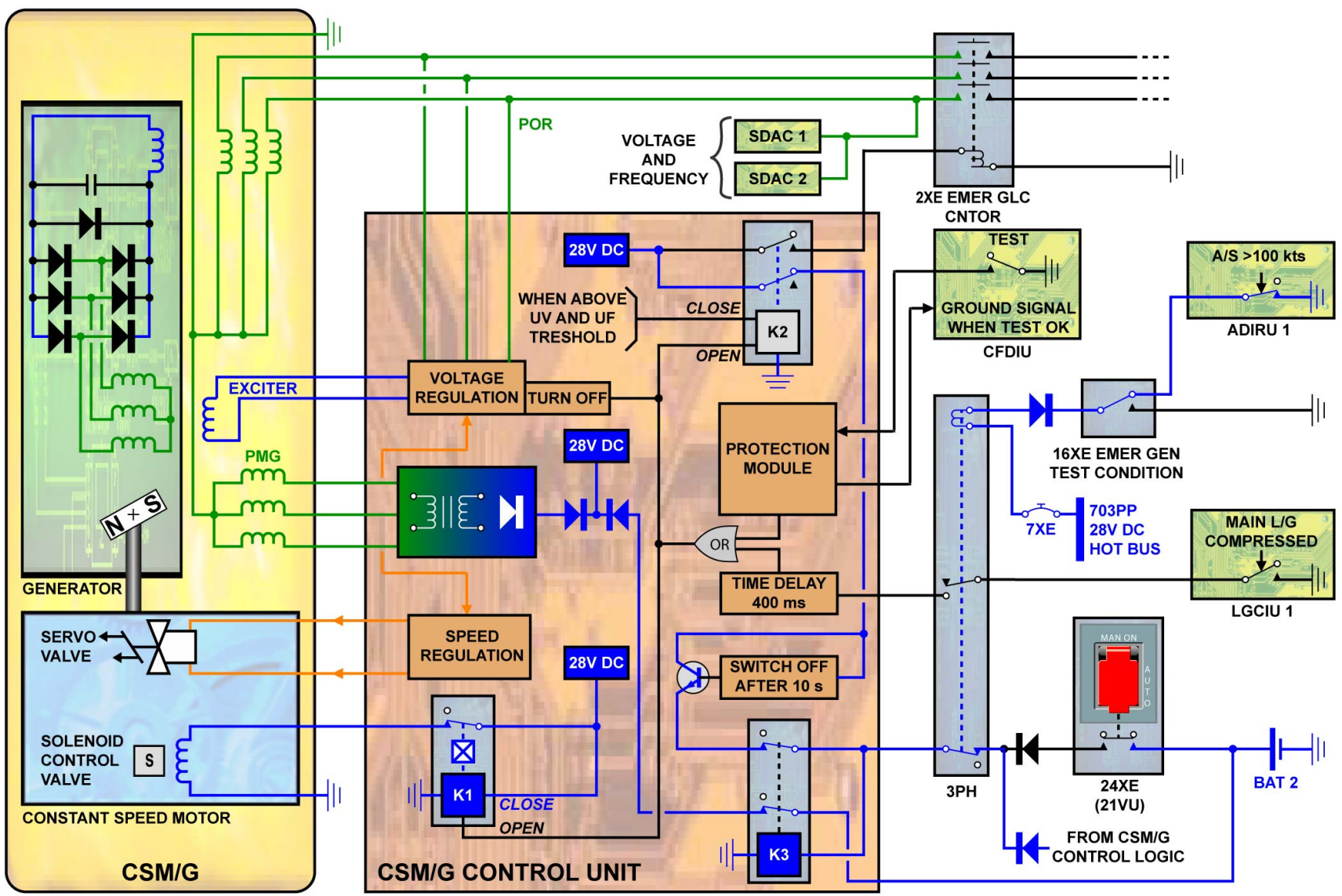
GENERATOR MONITORING

CSM/G GCU D/O (3)

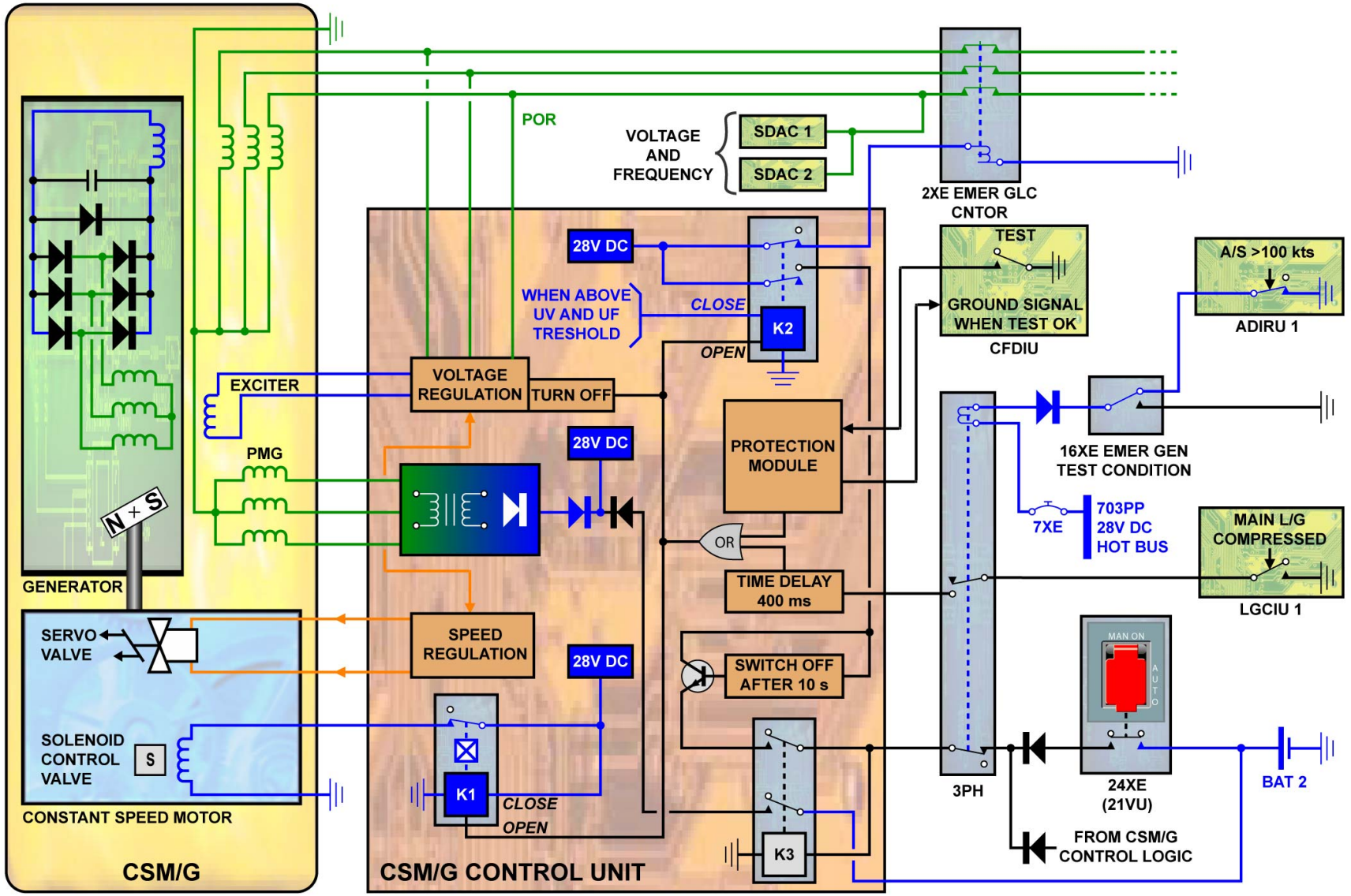
OPERATION

When the emergency generator is operating (frequency and voltage in tolerance) and supplying the ESSential bus network, it will do so as long as the A/C remains above 100kts and the main L/G is not compressed.
In emergency power condition (AC buses not powered, A/C in flight, and Airspeed greater than 100kts) the automatic control logic being set, the Generator Control Unit (GCU) internal 28V DC bus is supplied by battery 2 through relay K3. Relay K1 is then energized, allowing the solenoid control valve to be supplied by the internal bus (still on battery 2). Relay K3 is held closed by the GCU internal supply via relay K2 and the time delay-opening transistor.
The emergency generator stops as soon as the airspeed is below 100kts and the A/C is on ground. At 100kts a ground is removed from relay 3PH thus allowing for a discrete to be supplied to the CSM/G CU as soon as the Main L/G compresses. After a 400ms delay the GCU de-energizes relay K2 and K1, which in turn causes the EMER GLC to de-energize, and the stoppage of the servo control of the generator respectively.
When the EMERgency GENerator test pushbutton 16XE is pressed in, relay 3PH energizes simulating a loss of AC BUS 1 and AC BUS 2 and a speed higher than 100 kts. The generator then comes online supplying the ESSential bus network until 16XE is released.

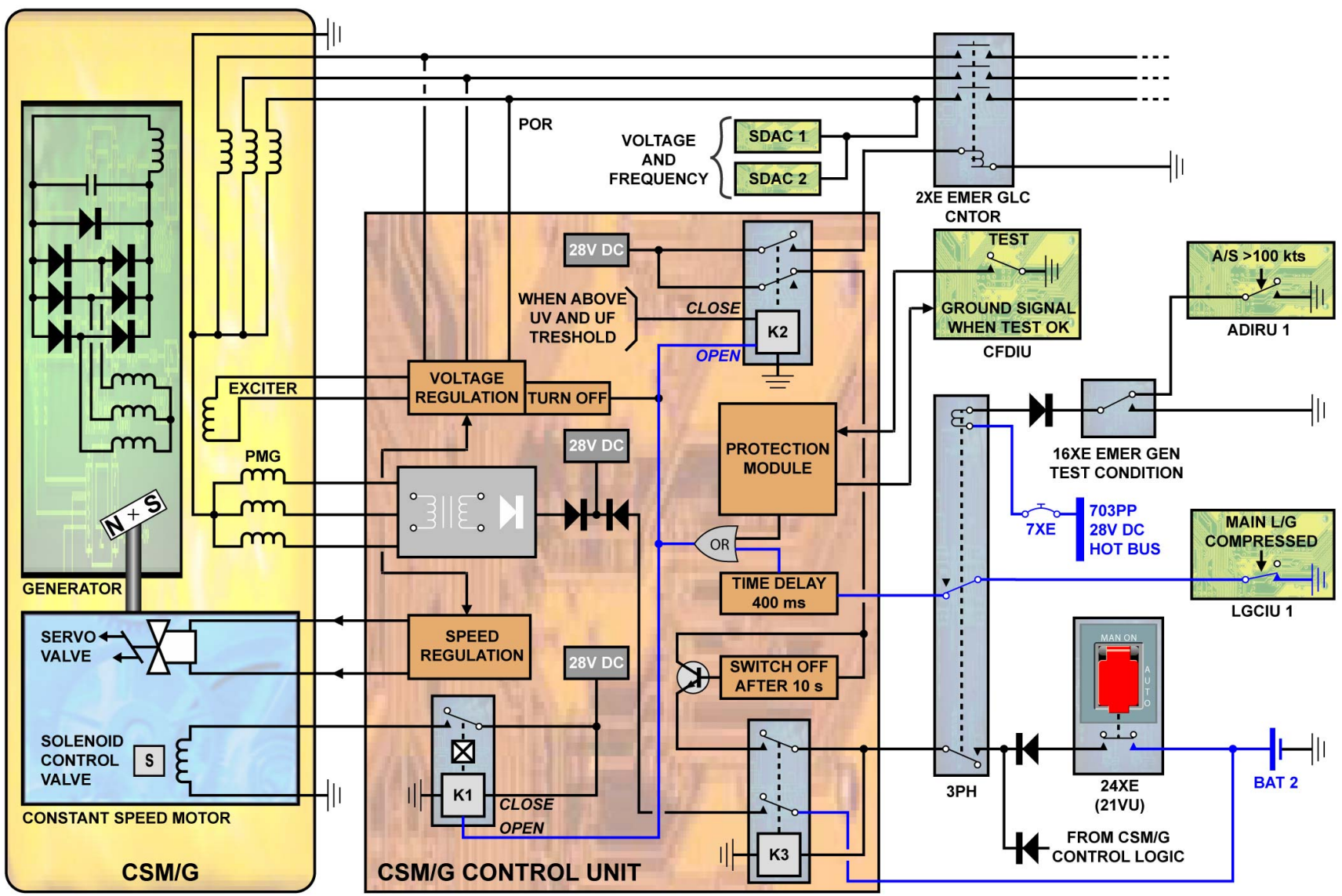
UGB13131 - U7ST0M0 - UM24DK000000001


POR
VOLTAGE AND FREQUENCY
SDAC 1
SDAC 2
2XE EMER GLC CNTOR
28V DC
WHEN ABOVE UV AND UF TRESHOLD
CLOSE
K2
OPEN
TEST
GROUND SIGNAL WHEN TEST OK
CFDIU
A/S >100 kts
ADIRU 1
EXCITER
VOLTAGE REGULATION
TURN OFF
PMG
28V DC
PROTECTION MODULE
16XE EMER GEN TEST CONDITION
7XE
703PP 28V DC HOT BUS
MAIN L/G COMPRESSED
LGCIU 1
OR
TIME DELAY 400 ms
N + S
GENERATOR
SERVO VALVE
SPEED REGULATION
28V DC
SWITCH OFF AFTER 10 s
MAN ON
AUTO
SOLENOID CONTROL VALVE
S
K1
CLOSE
OPEN
3PH
24XE (21VU)
BAT 2
CONSTANT SPEED MOTOR
K3
FROM CSM/G CONTROL LOGIC
CSM/G
CSM/G CONTROL UNIT

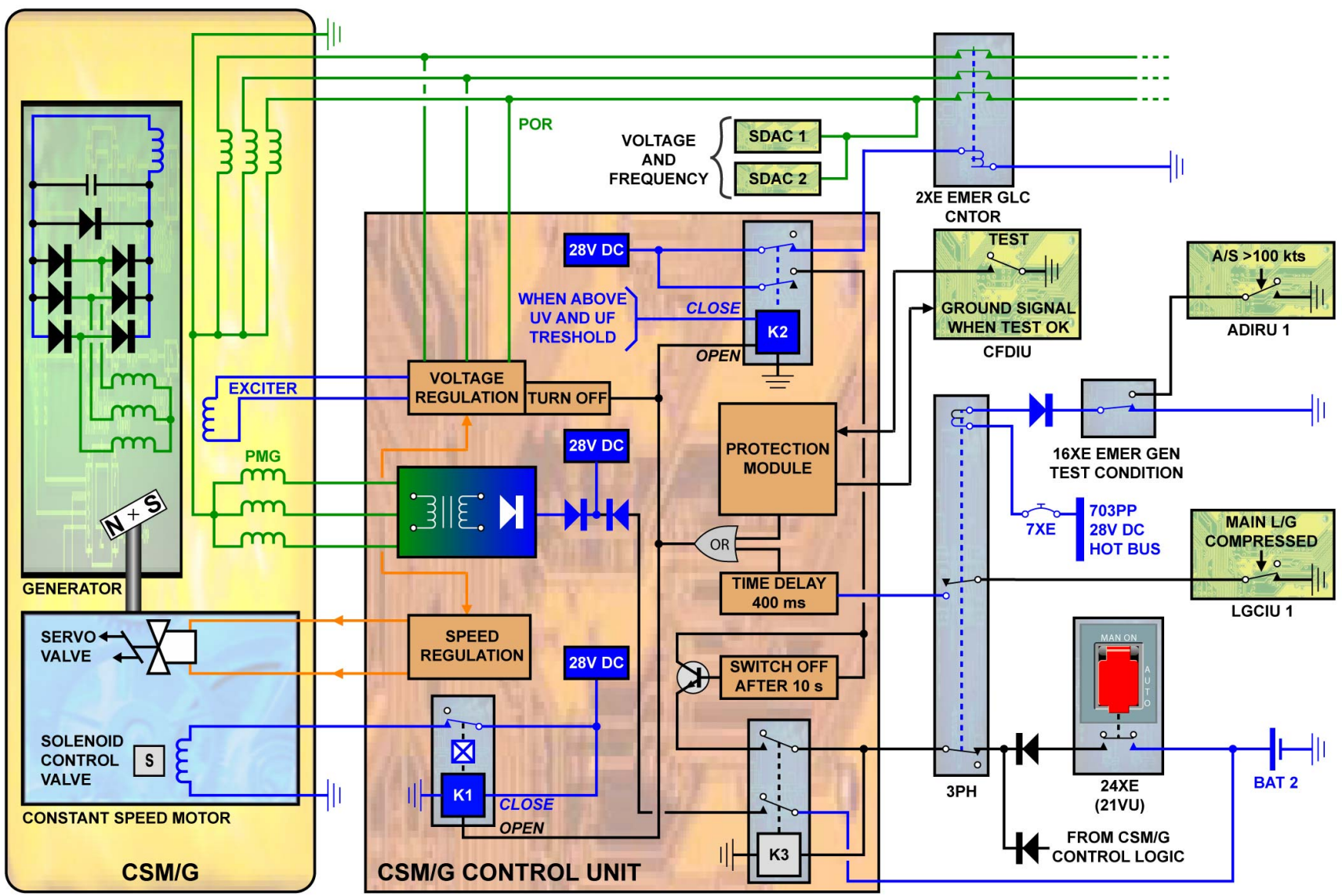
OPERATION


POR
VOLTAGE AND FREQUENCY
SDAC 1
SDAC 2
2XE EMER GLC CNTOR
28V DC
WHEN ABOVE UV AND UF TRESHOLD
CLOSE
K2
OPEN
TEST
GROUND SIGNAL WHEN TEST OK
CFDIU
A/S >100 kts
ADIRU 1
EXCITER
VOLTAGE REGULATION
TURN OFF
PMG
28V DC
PROTECTION MODULE
16XE EMER GEN TEST CONDITION
7XE
703PP 28V DC HOT BUS
MAIN L/G COMPRESSED
LGCIU 1
OR
TIME DELAY 400 ms
GENERATOR
N + S
SERVO VALVE
SPEED REGULATION
28V DC
SWITCH OFF AFTER 10 s
MAN ON
AUTO
SOLENOID CONTROL VALVE
S
K1
CLOSE
OPEN
3PH
24XE (21VU)
BAT 2
CONSTANT SPEED MOTOR
K3
FROM CSM/G CONTROL LOGIC
CSM/G
CSM/G CONTROL UNIT

OPERATION


POR
VOLTAGE AND FREQUENCY
SDAC 1
SDAC 2
2XE EMER GLC CNTOR
28V DC
WHEN ABOVE UV AND UF TRESHOLD
CLOSE
K2
OPEN
TEST
GROUND SIGNAL WHEN TEST OK
CFDIU
A/S >100 kts
ADIRU 1
EXCITER
VOLTAGE REGULATION
TURN OFF
PMG
28V DC
PROTECTION MODULE
16XE EMER GEN TEST CONDITION
7XE
703PP 28V DC HOT BUS
MAIN L/G COMPRESSED
LGCIU 1
OR
TIME DELAY 400 ms
GENERATOR
N + S
SERVO VALVE
SPEED REGULATION
28V DC
SWITCH OFF AFTER 10 s
MAN ON
AUTO
SOLENOID CONTROL VALVE
S
K1
CLOSE
OPEN
3PH
24XE (21VU)
BAT 2
CONSTANT SPEED MOTOR
K3
FROM CSM/G CONTROL LOGIC
CSM/G
CSM/G CONTROL UNIT

OPERATION


POR
VOLTAGE AND FREQUENCY
SDAC 1
SDAC 2
2XE EMER GLC CNTOR
28V DC
WHEN ABOVE UV AND UF TRESHOLD
CLOSE
K2
OPEN
TEST
GROUND SIGNAL WHEN TEST OK
CFDIU
A/S >100 kts
ADIRU 1
EXCITER
VOLTAGE REGULATION
TURN OFF
PMG
28V DC
PROTECTION MODULE
16XE EMER GEN TEST CONDITION
7XE
703PP 28V DC HOT BUS
MAIN L/G COMPRESSED
LGCIU 1
OR
TIME DELAY 400 ms
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GENERATOR
SERVO VALVE
SPEED REGULATION
28V DC
SWITCH OFF AFTER 10 s
MAN ON
AUTO
SOLENOID CONTROL VALVE
S
K1
CLOSE
OPEN
K3
3PH
24XE (21VU)
BAT 2
FROM CSM/G CONTROL LOGIC
CONSTANT SPEED MOTOR
CSM/G
CSM/G CONTROL UNIT

OPERATION

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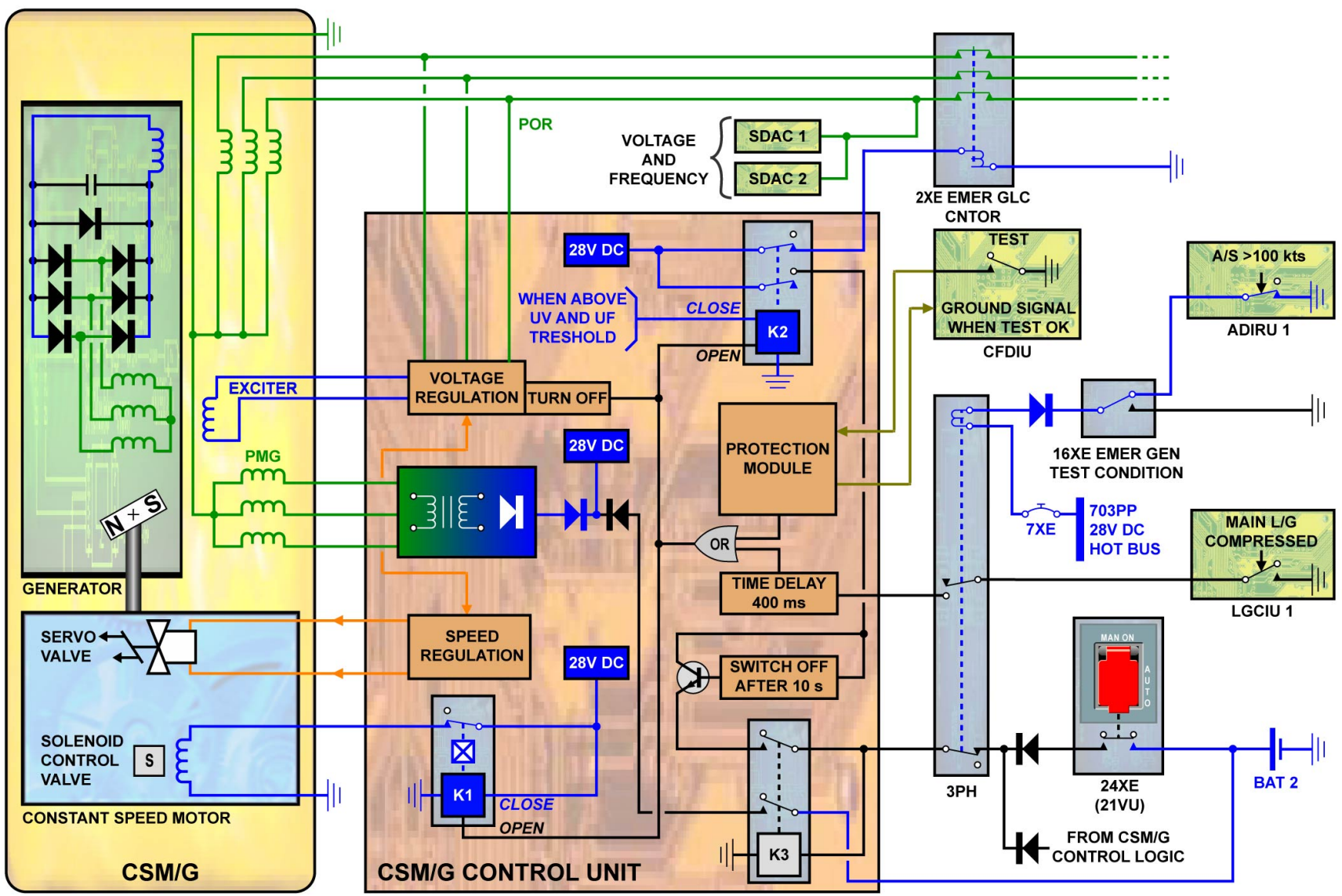
CSM/G GCU D/O (3)

BITE

The CSM/G GCU gives a type 3 BITE system. The CSM/G GCU is linked to the Centralized Fault Display Interface Unit (CFDIU) by two discrete links (type 3 system) and has a simplified and limited interactive dialog. Tests can be launched from the GCU EMER page on the MCDU.

UGB13131 - U7ST0M0 - UM24DK000000001


POR
VOLTAGE AND FREQUENCY
SDAC 1
SDAC 2
2XE EMER GLC CNTOR
28V DC
WHEN ABOVE UV AND UF TRESHOLD
CLOSE
K2
OPEN
TEST
GROUND SIGNAL WHEN TEST OK
CFDIU
A/S >100 kts
ADIRU 1
EXCITER
VOLTAGE REGULATION
TURN OFF
PMG
28V DC
PROTECTION MODULE
16XE EMER GEN TEST CONDITION
7XE
703PP 28V DC HOT BUS
MAIN L/G COMPRESSED
LGCIU 1
N + S
GENERATOR
OR
TIME DELAY 400 ms
SERVO VALVE
SPEED REGULATION
28V DC
SWITCH OFF AFTER 10 s
MAN ON
AUTO
SOLENOID CONTROL VALVE
S
K1
CLOSE
OPEN
3PH
24XE (21VU)
BAT 2
CONSTANT SPEED MOTOR
K3
FROM CSM/G CONTROL LOGIC
CSM/G
CSM/G CONTROL UNIT

BITE

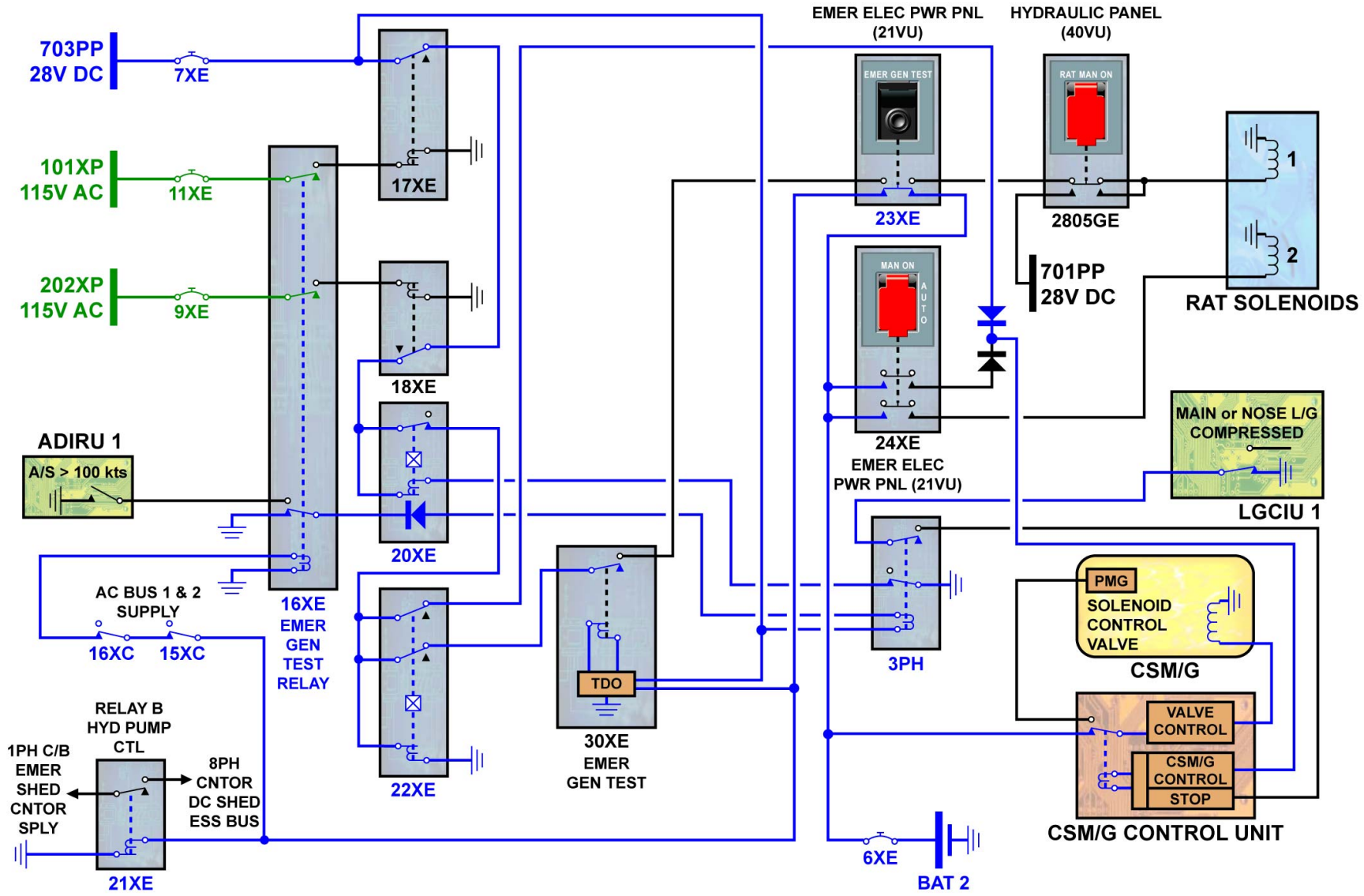
CSM/G OPERATIONAL TEST ELECTRICAL CIRCUIT (3)

TEST PUSHBUTTON DEPRESSED

relays 3PH simulates flight condition
-Relay 16XE simulates aircraft speed above 100 knots
-Relay 20XE and 30 XE are temporized relays
-Relay 22XE controls the csm/g electro valve supply
All those relays are supplied with 28 VDC from the batteries closing their respective contacts and AC buses 1 and 2 not supplied.
This then causes the emergency generator to come online. The emergency generator will supply the ESSential buses (DC ESSential bus through the ESS TR).
The ESSential shed buses are de-energized through relay 21XE

NOTE: The blue hydraulic system must be pressurized; AC BUS 1 and 2 must be supplied.
Ram Air Turbine (RAT) extension is inhibited by relay 30XE if 23XE is released before 22XE closes.
The diagram shows the system with EMER GEN TEST P/BSW pressed in, before relay 22XE time delay elapsed.

UGB13131 - U7ST0M0 - UM24O2000000001



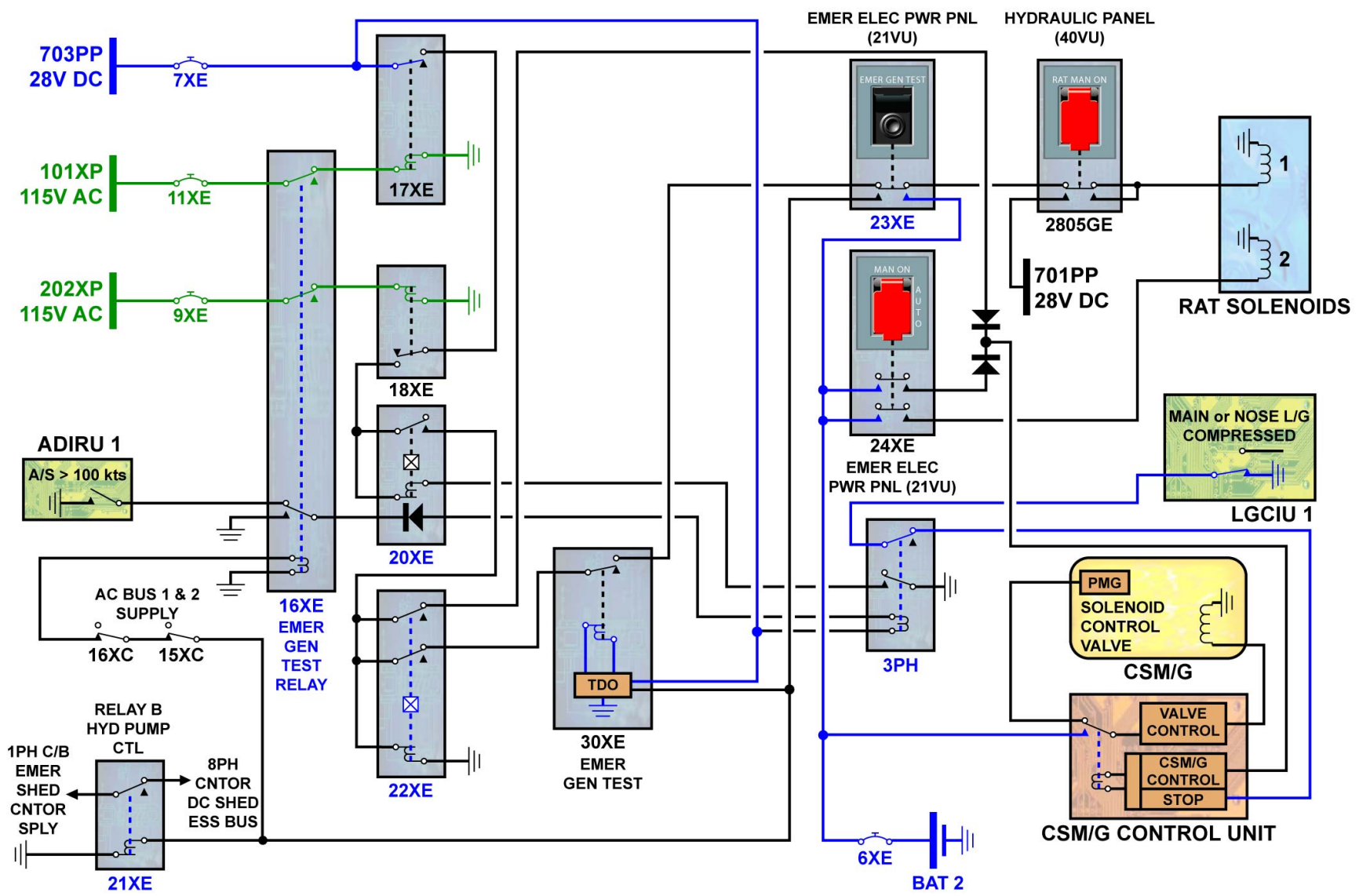
TEST PUSHBUTTON DEPRESSED

CSM/G OPERATIONAL TEST ELECTRICAL CIRCUIT (3)

TEST PUSHBUTTON RELEASED OUT

When the EMERgency GENerator TEST P/BSW is released, relays 16XE, 20XE, 21XE and 22XE all de-energize returning the A/C electrical power distribution network to normal. Relay 30XE contacts remain in the energized state (time delay open) for several seconds to ensure that the RAT solenoid does not activate a RAT extension. Relay 3PH contacts then send the Landing Gear compressed discrete to the EMERgency GENerator (GCU) that initiates a generator stop.

UGB13131 - U7ST0M0 - UM24O2000000001



TEST PUSHBUTTON RELEASED OUT

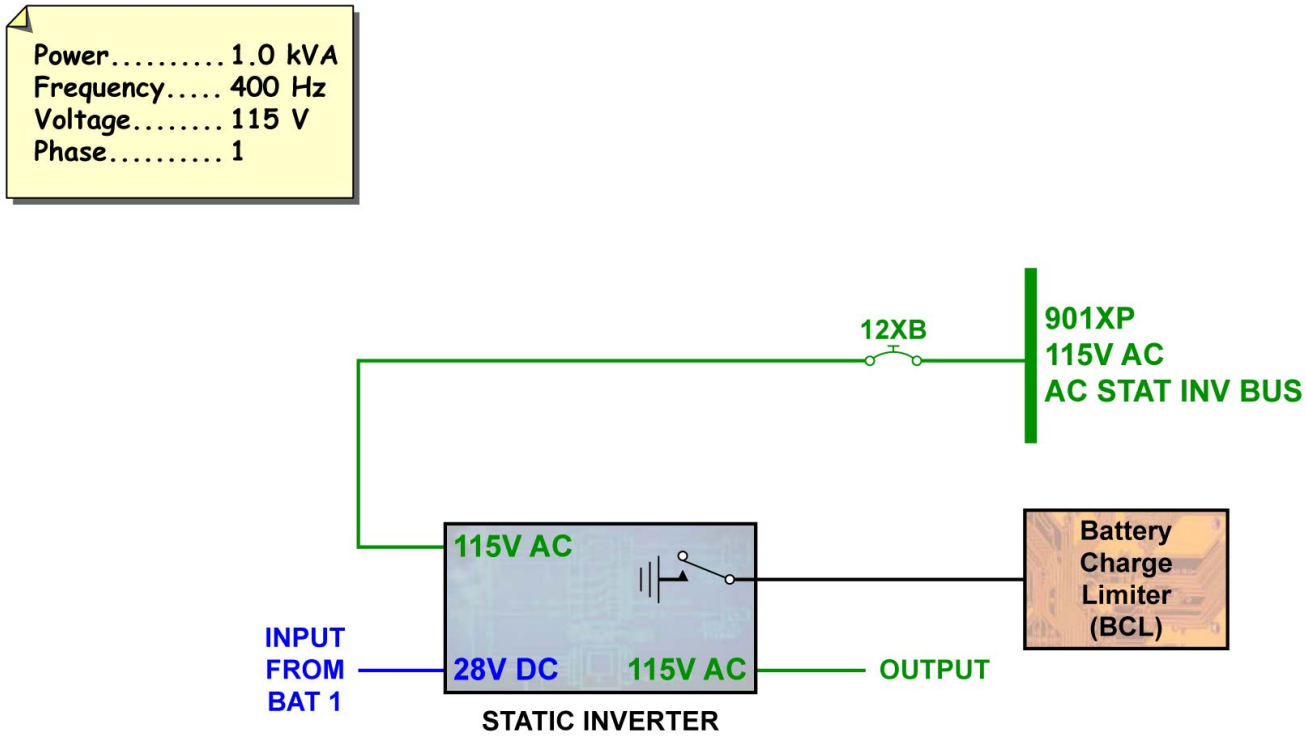
STATIC INVERTER DESCRIPTION/OPERATION (3)

GENERAL

A STATic INVerter transforms the direct current from battery 1 into a single-phase alternating current. The STAT INV characteristics are:
- 1 kVA nominal power,
- 115V AC, 400 Hz, single phase.

The STAT INV is used in the following cases:
- APU start (supply of fuel pump),
- engine start on battery (ignition),
- emergency configuration.

UGB13131 - U7ST0M0 - UM24DL000000001



UGB13131 - U7ST0M0 - UM24DL000000001

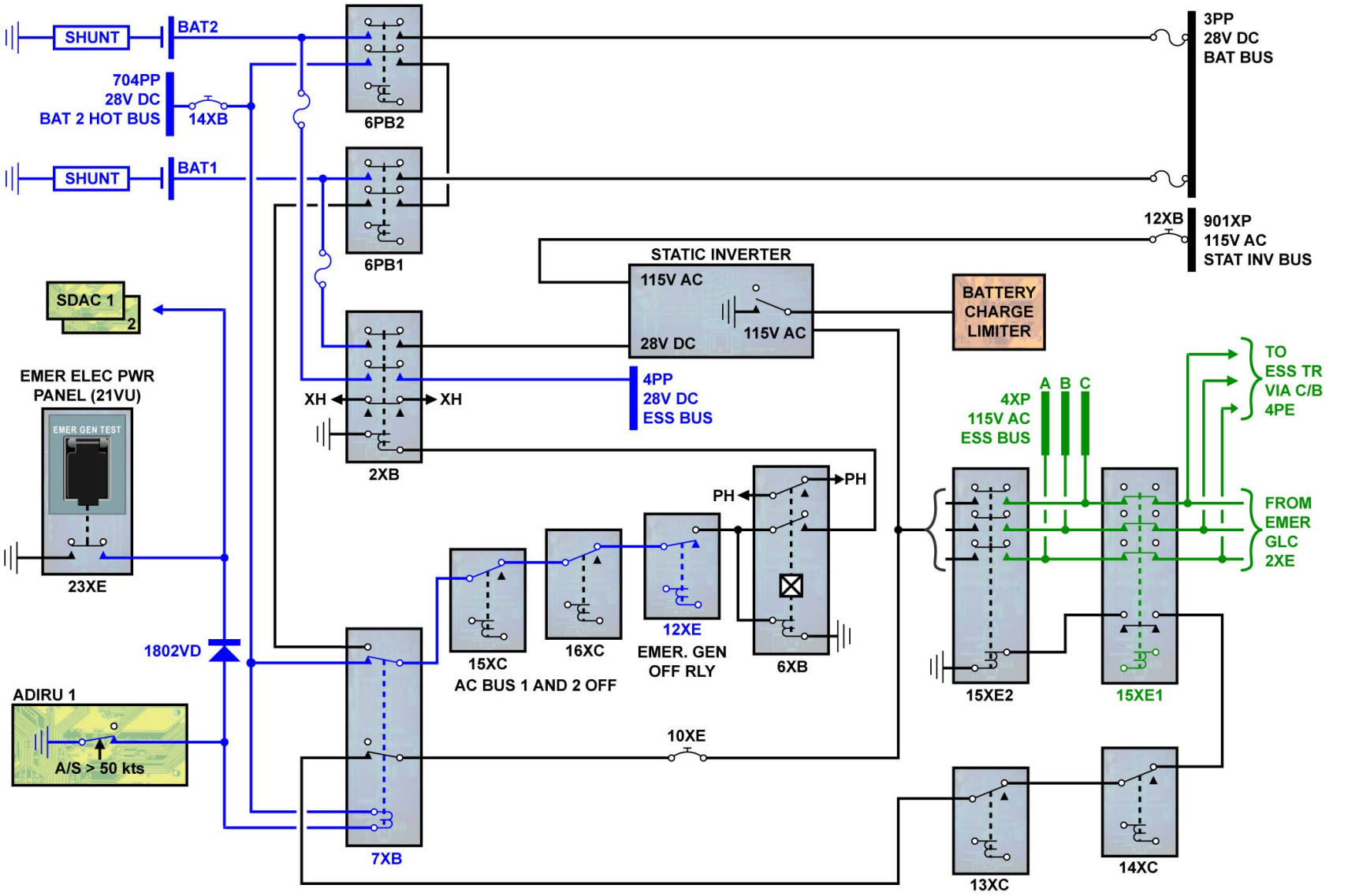
STATIC INVERTER DESCRIPTION/OPERATION (3)

EMERGENCY CONFIGURATION

AIRSPEED ABOVE 100 KTS

In this configuration the Constant Speed Motor/Generator (CSM/G) supplies the AC ESSential BUS and DC ESS BUS through the ESS Transformer Rectifier (TR) unit. The STAT INV is not electrically supplied.

UGB13131 - U7ST0M0 - UM24DL000000001



EMERGENCY CONFIGURATION - AIRSPEED ABOVE 100 KTS

UGB13131 - U7ST0M0 - UM24DL000000001

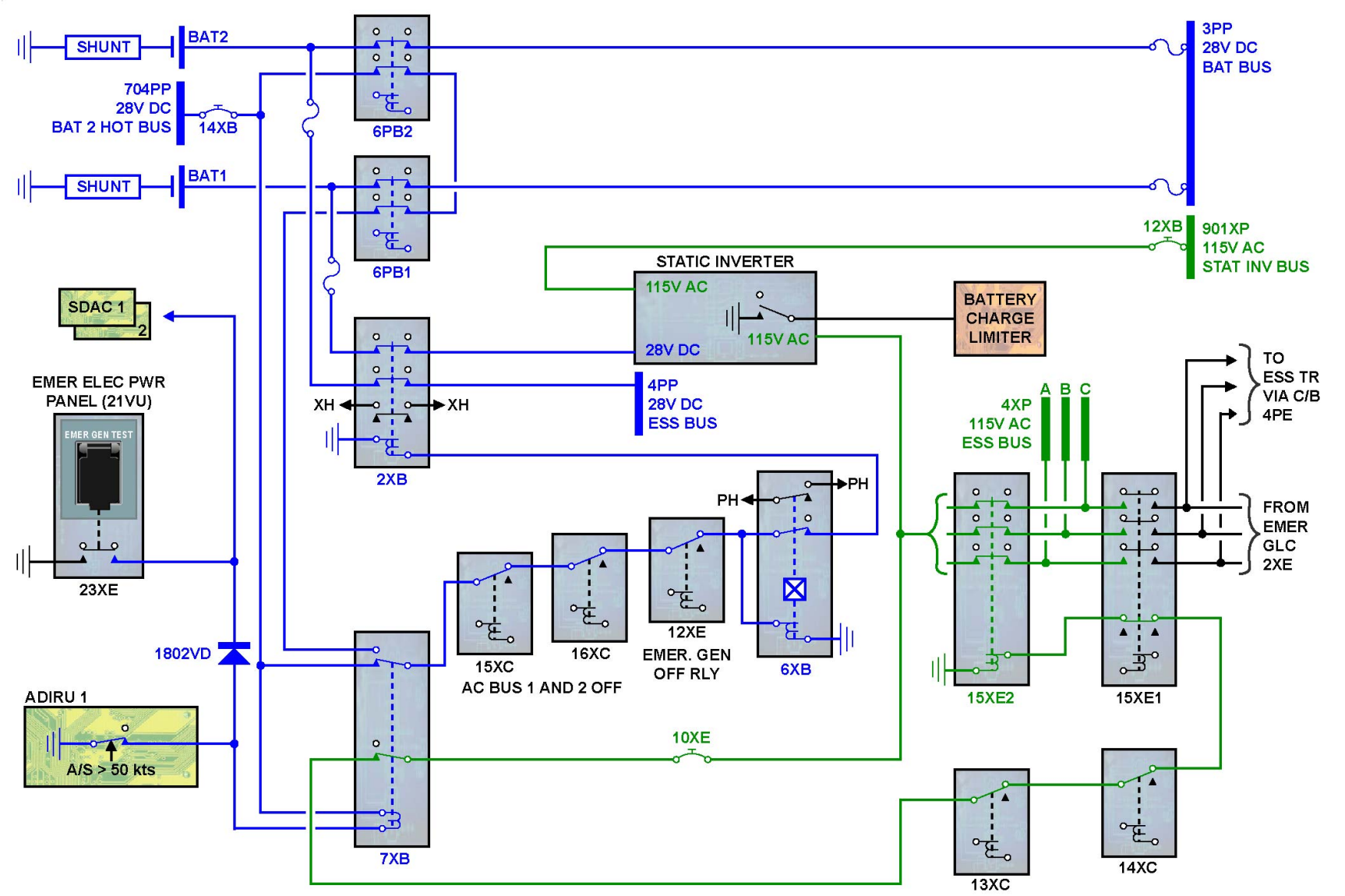
STATIC INVERTER DESCRIPTION/OPERATION (3)

EMERGENCY CONFIGURATION (continued)

AIRSPEED BETWEEN 50 AND 100 KTS

In this configuration the emergency generator is no longer connected to the aircraft network. The AC ESS BUS is supplied by the STAT INV, which is supplied from battery 1. On the other hand, the DC ESS BUS is directly supplied by battery 2. The AC STAT INV BUS is also supplied by the STAT INV. This bus is used for the APU fuel pump supply. The AC and DC SHEDdable ESS BUS are no longer supplied.

UGB13131 - U7ST0M0 - UM24DL000000001



EMERGENCY CONFIGURATION - AIRSPEED BETWEEN 50 AND 100 KTS

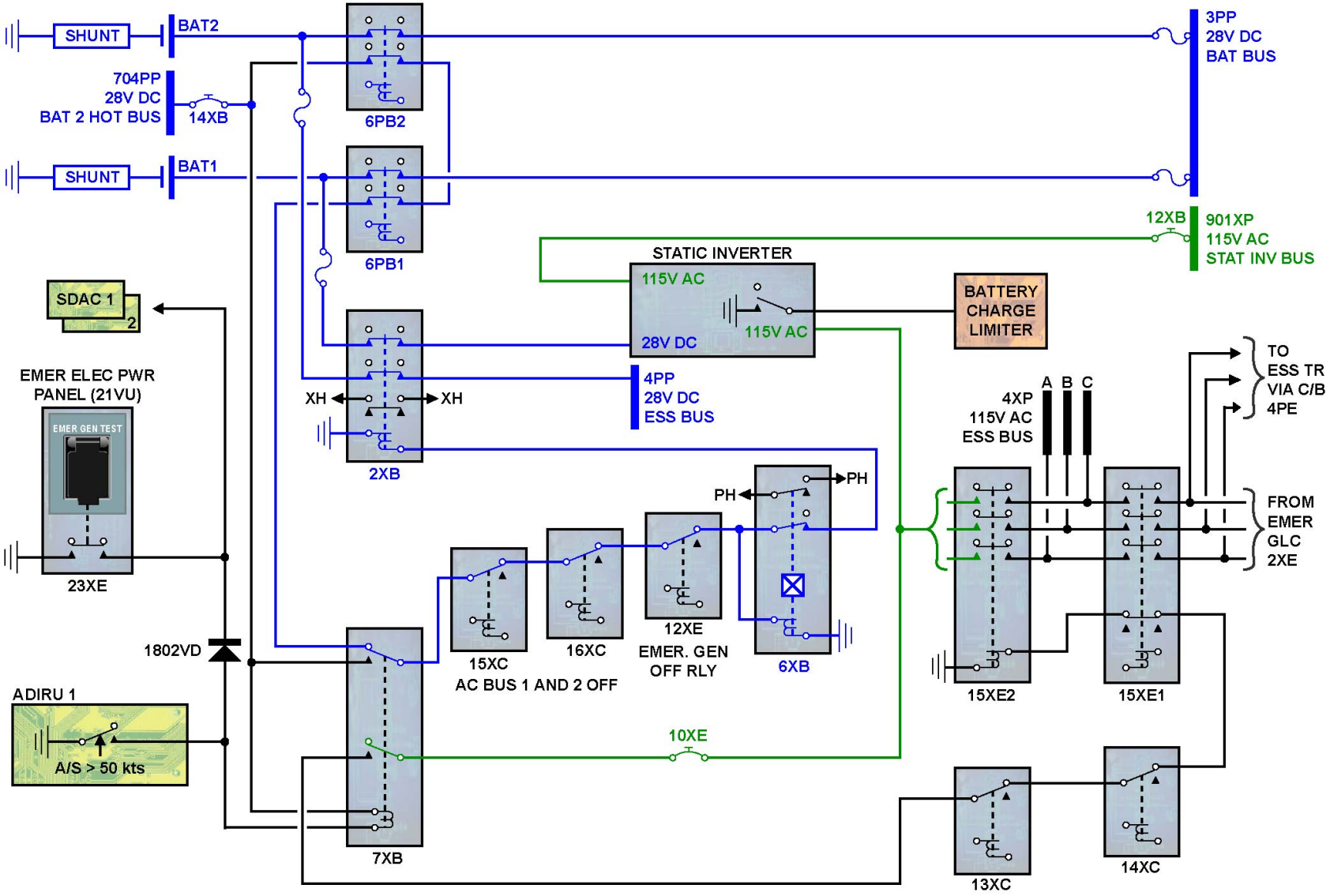
STATIC INVERTER DESCRIPTION/OPERATION (3)

EMERGENCY CONFIGURATION (continued)

AIRSPEED BELOW 50 KTS

In this configuration the AC ESS BUS is no longer connected to the STAT INV. The DC ESS BUS and the AC STAT INV BUS remain supplied.

UGB13131 - U7ST0M0 - UM24DL000000001



EMERGENCY CONFIGURATION - AIRSPEED BELOW 50 KTS

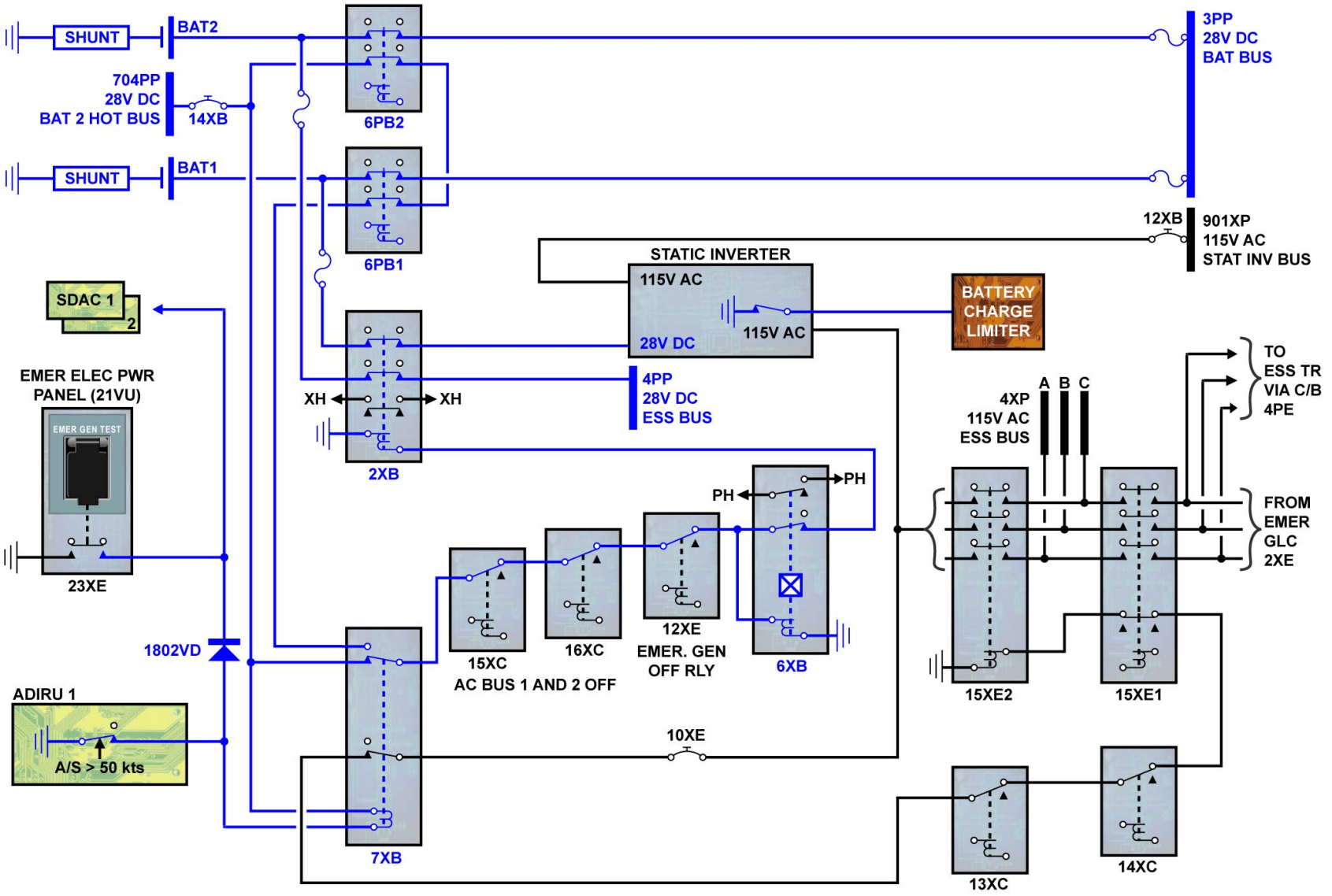
UGB13131 - U7ST0M0 - UM24DL000000001

STATIC INVERTER DESCRIPTION/OPERATION (3)

MONITORING

STAT INV faults are signaled to the Battery Charge Limiter (BCL). The BCL memorizes the faults as class 1 failures, which will be displayed on the ECAM upper display when the aircraft electrical network is supplied.
The following STAT INV parameters are monitored:
- overheat,
- output/input over voltage,
- input under voltage.

UGB13131 - U7ST0M0 - UM24DL000000001


SHUNT
BAT2
704PP
28V DC
BAT 2 HOT BUS
14XB
6PB2
SHUNT
BAT1
6PB1
3PP
28V DC
BAT BUS
12XB
901XP
115V AC
STAT INV BUS
STATIC INVERTER
115V AC
28V DC
115V AC
BATTERY CHARGE LIMITER
SDAC 1
2
EMER ELEC PWR PANEL (21VU)
EMER GEN TEST
23XE
XH
XH
2XB
4PP
28V DC
ESS BUS
A B C
4XP
115V AC
ESS BUS
TO ESS TR VIA C/B 4PE
FROM EMER GLC 2XE
PH
PH
6XB
1802VD
15XC
AC BUS 1 AND 2 OFF
16XC
12XE
EMER. GEN OFF RLY
15XE2
15XE1
ADIRU 1
A/S > 50 kts
7XB
10XE
13XC
14XC

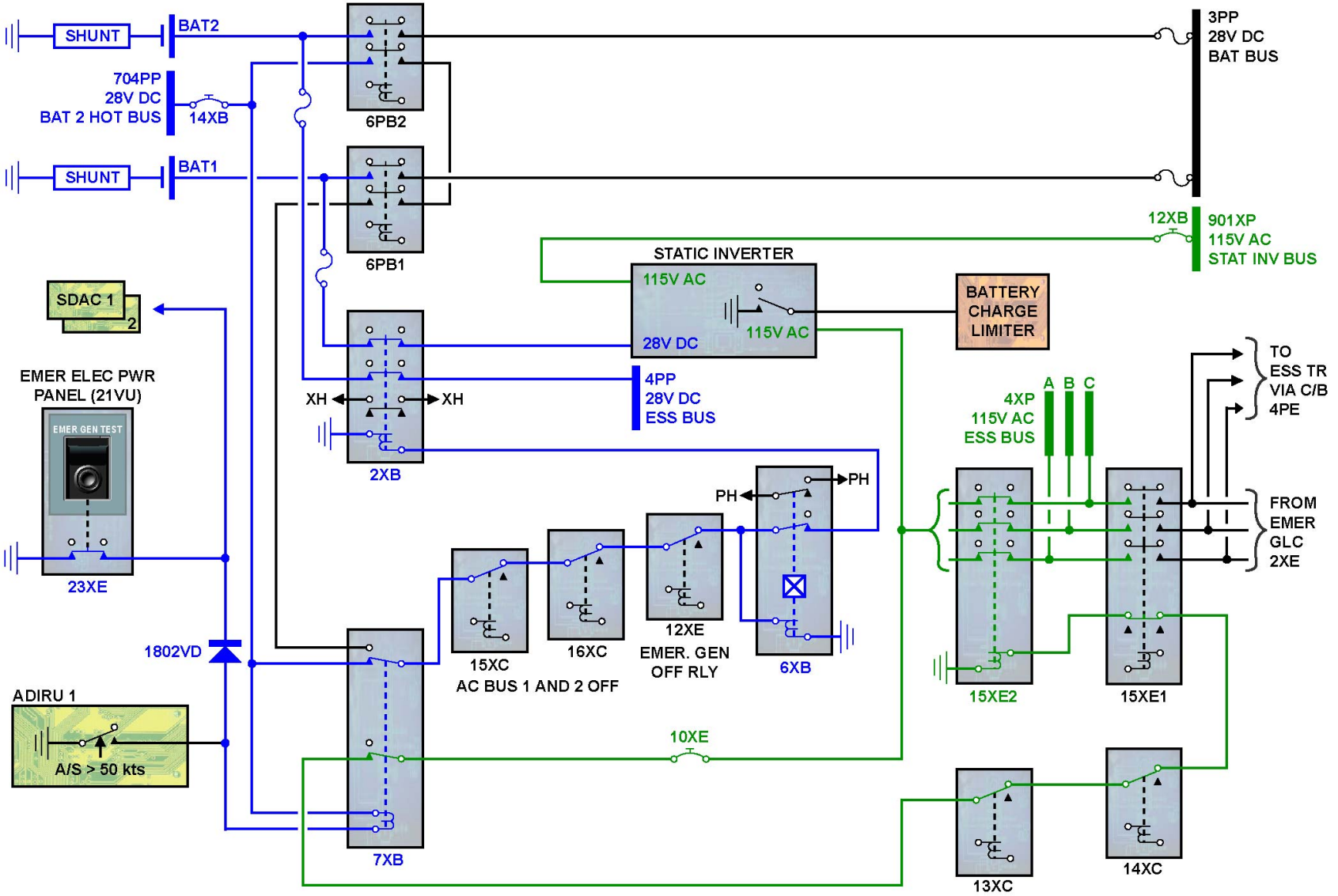
MONITORING

STATIC INVERTER DESCRIPTION/OPERATION (3)

TEST

To perform the STAT INV test, the EMERgency GENerator TEST P/BSW is pressed in. This simulates an aircraft speed above 50 kts. The STAT INV parameters have to be checked on the ECAM display.

UGB13131 - U7ST0M0 - UM24DL000000001


SHUNT
BAT2
704PP
28V DC
BAT 2 HOT BUS
14XB
6PB2
3PP
28V DC
BAT BUS
SHUNT
BAT1
6PB1
12XB
901XP
115V AC
STAT INV BUS
STATIC INVERTER
115V AC
28V DC
115V AC
BATTERY
CHARGE
LIMITER
SDAC 1
2
EMER ELEC PWR
PANEL (21VU)
EMER GEN TEST
23XE
XH
XH
2XB
4PP
28V DC
ESS BUS
4XP
115V AC
ESS BUS
A B C
TO
ESS TR
VIA C/B
4PE
FROM
EMER
GLC
2XE
PH
PH
6XB
1802VD
15XC
AC BUS 1 AND 2 OFF
16XC
12XE
EMER. GEN
OFF RLY
15XE2
15XE1
ADIRU 1
A/S > 50 kts
7XB
10XE
13XC
14XC

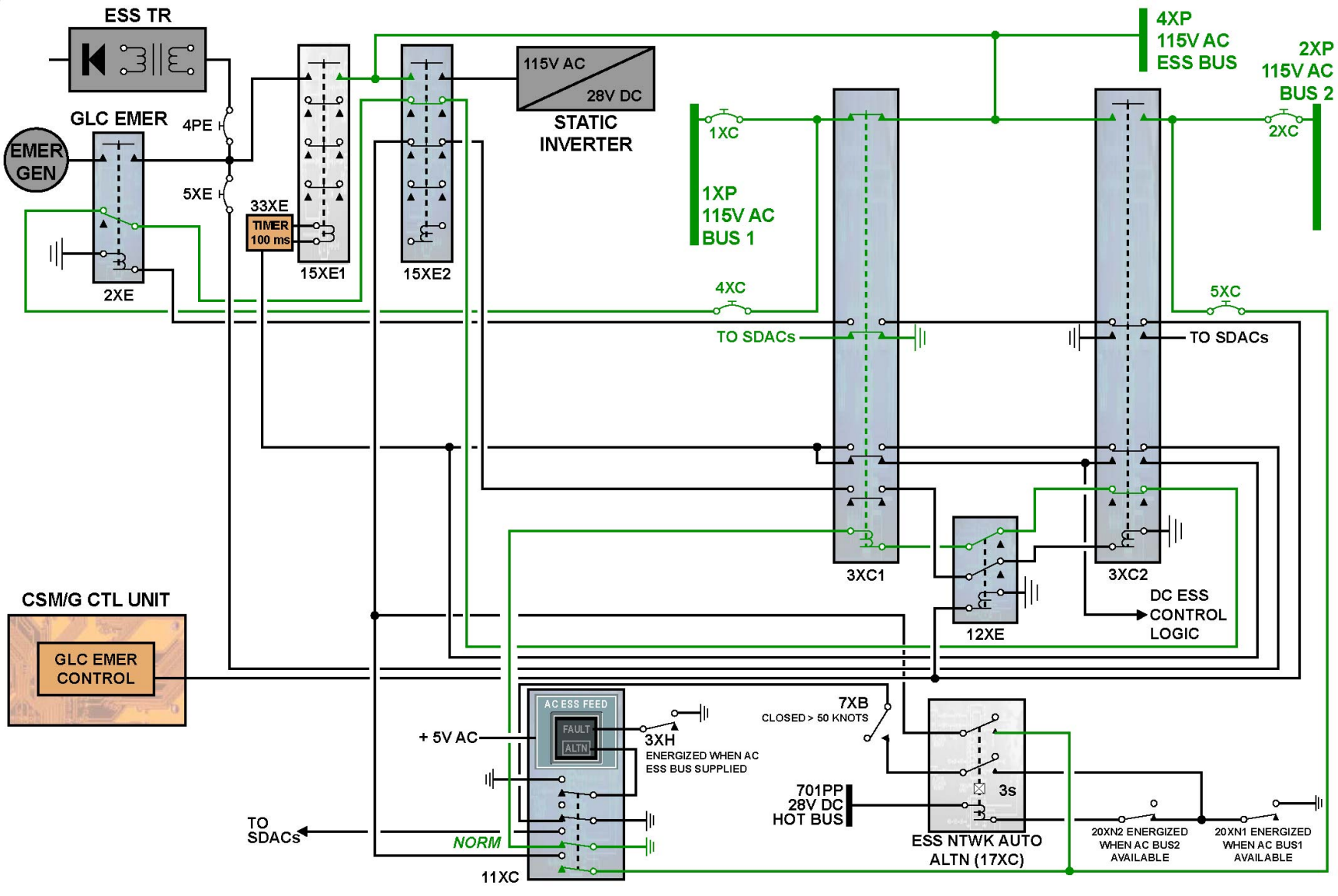
TEST

AC ESSENTIAL BUS SWITCHING (3)

NORMAL CONFIGURATION

In normal configuration, the aircraft electrical network is normally supplied and the AC ESSential BUS is directly connected to AC BUS 1.
Contactor 3XC1 is energized under several conditions:
- AC BUS 1 is supplied,
- 3XC2 is in de-energized position,
- 12XE and 2XE not energized (EMER GEN not operative),
- AC ESS FEED P/BSW (11XC) in normal position (pressed in). The status of AC ESS BUS SWITCHING contactors (3XC1 and 3XC2), the position of the AC ESS FEED P/BSW (11XC) and the AC source supplying the AC ESS network are sent to the SDACs for display on the AC ELEC ECAM page.

UGB13131 - U7ST0M0 - UM24DM000000001



NORMAL CONFIGURATION

AC ESSENTIAL BUS SWITCHING (3)

AC BUS 1 LOSS

AUTO SWITCHING FUNCTION

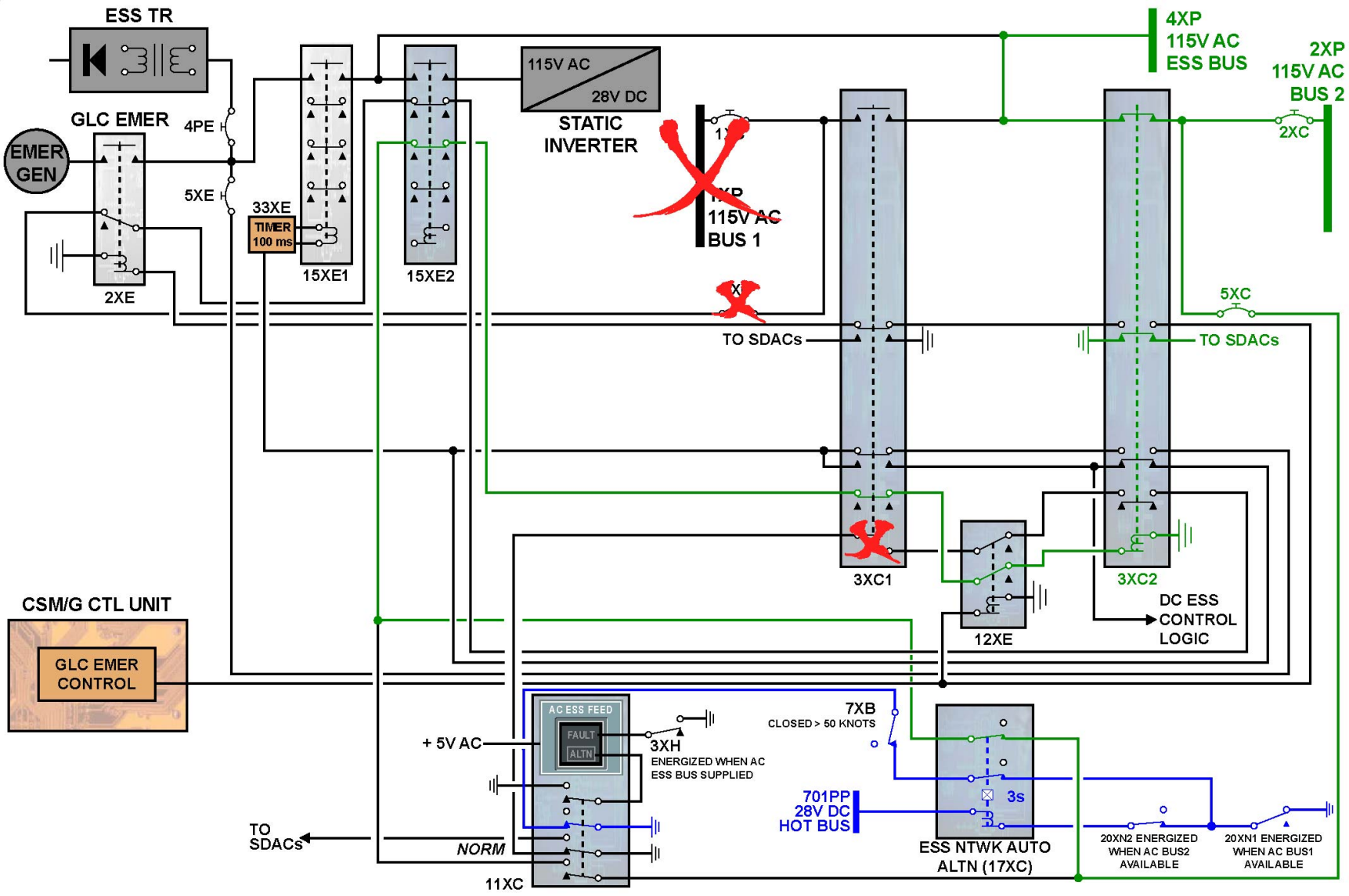
Automatic switching is done in flight and on ground if the AC ESS FEED P/BSW (11XC) is pressed in (normal position).
As soon as AC BUS 1 is not supplied, the following events occur (provided AC BUS 2 is supplied):
- 3XC1 is de-energized and 20XN1 provides ground to 17XC through 20 XN2,
- after 3 seconds (17 XC time delay), 3XC2 is energized.

The AC ESS network is recovered automatically from AC BUS 2.

NOTE: During the time delay of 3 seconds, there is a possibility of manual switching by the flight crew.

If Airspeed > 50 kts (from ADIRU1), 7XB is energized. 17XC is self-grounded through 20XN2, 7XB, and 11XC.
If the AC BUS 1 is recovered, AC ESS BUS remains on AC BUS 2.
If the AC ESS FEED P/BSW 11XC is cycled (released out and pushed back in), AC ESS BUS will switch back to the AC BUS 1. If Airspeed < 50 KTS, 7XB is de-energized. So, if the AC BUS 1 is recovered, AC ESS BUS will automatically switch back to the AC BUS 1.

UGB13131 - U7ST0M0 - UM24DM000000001



AC BUS 1 LOSS - AUTO SWITCHING FUNCTION

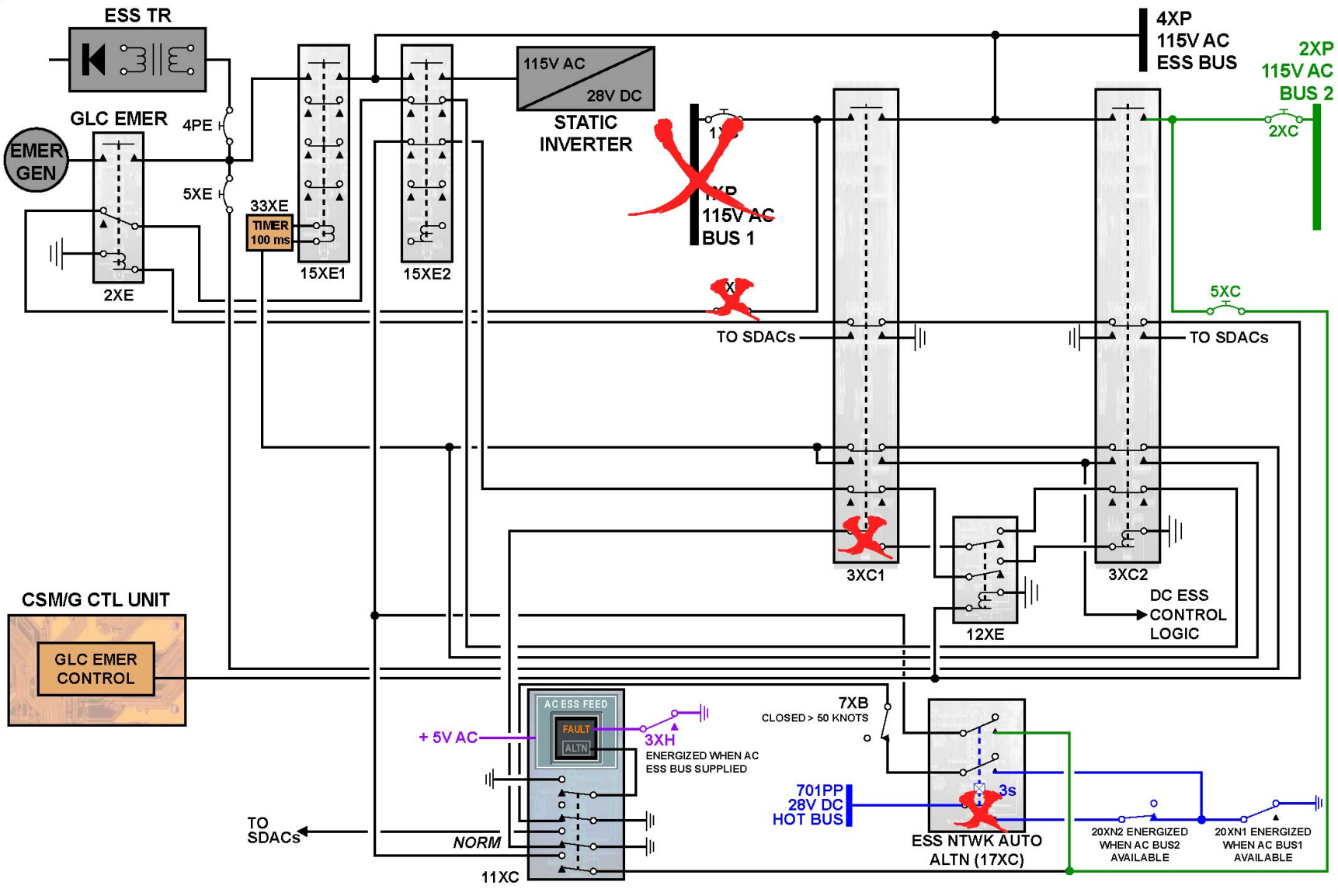
AC ESSENTIAL BUS SWITCHING (3)

AC BUS 1 LOSS (continued)

AUTO SWITCHING FAULT

In case of automatic switching failure (17 XC failure for instance), AC ESS BUS is no longer supplied.
3XH provides a ground. The FAULT legend on the AC ESS FEED P/BSW (11XC) comes on. The AC ESS FEED P/BSW has to be released out to do a manual switching.

UGB13131 - U7ST0M0 - UM24DM000000001



AC BUS 1 LOSS - AUTO SWITCHING FAULT

AC ESSENTIAL BUS SWITCHING (3)

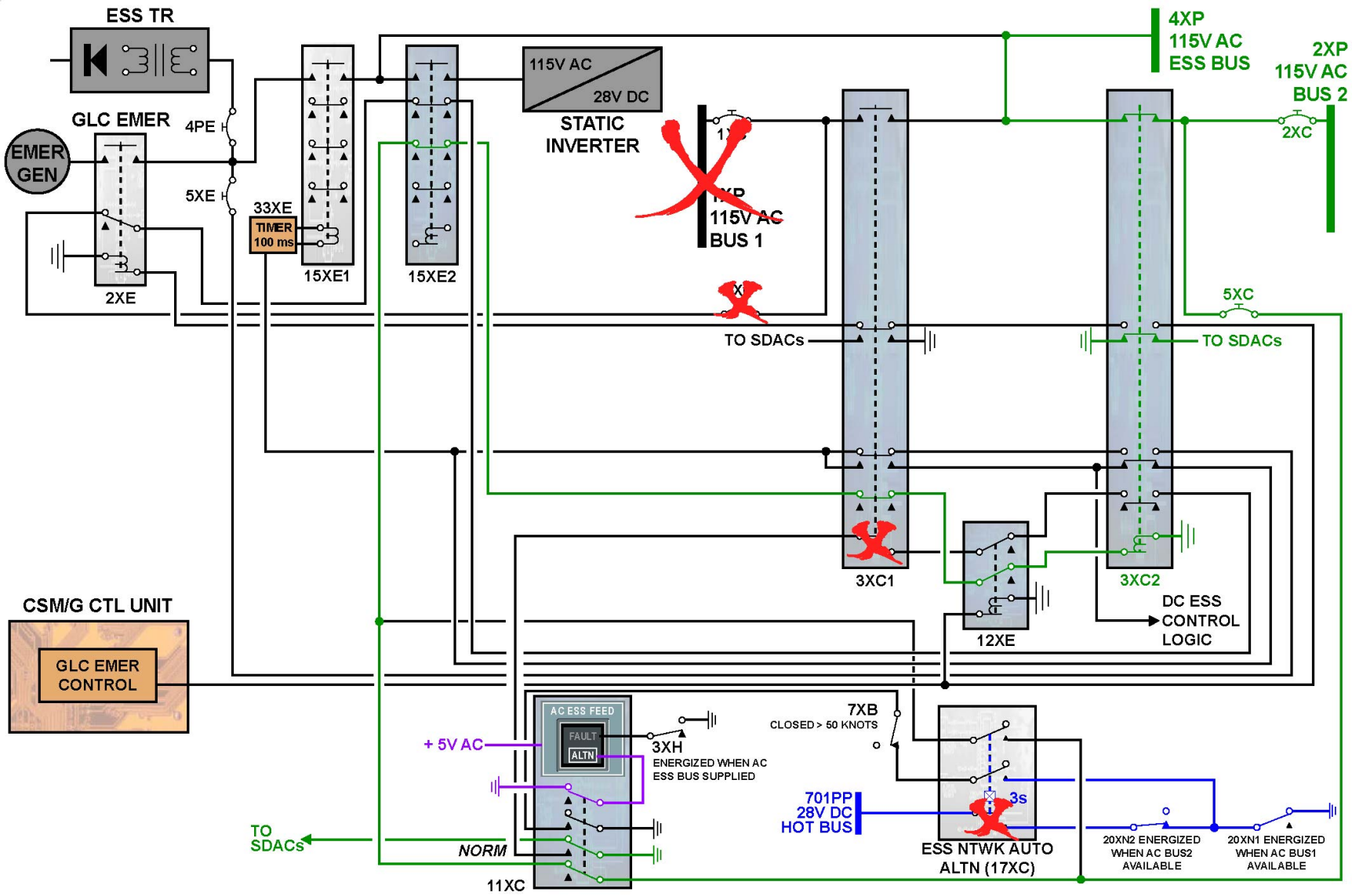
AC BUS 1 LOSS (continued)

MANUAL SWITCHING

When the AC ESS FEED P/BSW is released out. The following events occur:

- ALTN legend comes on white,
- 3XC2 is energized,
- the AC ESS BUS is recovered from AC BUS 2,
- 3XH opens,
- the FAULT legend on the AC ESS FEED P/BSW goes off.

UGB13131 - U7ST0M0 - UM24DM000000001



AC BUS 1 LOSS - MANUAL SWITCHING

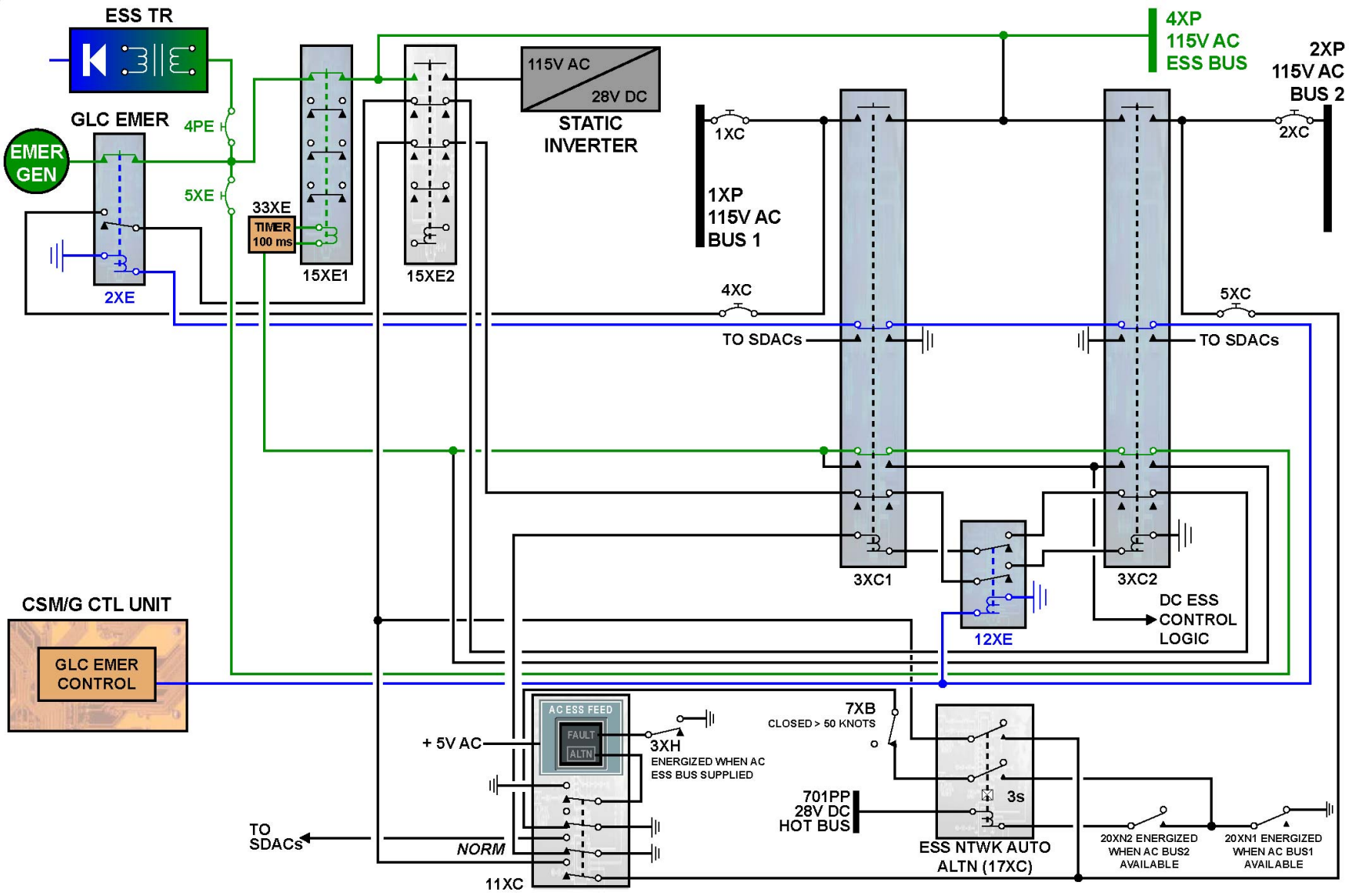
AC ESSENTIAL BUS SWITCHING (3)

AC BUS 1 AND 2 LOSS

In this configuration, the AC emergency generator is connected to the AC ESS BUS. The ESS Transformer Rectifier (TR) is supplied.

NOTE: The timer 33XE avoids the closure of the contactor 15XE1 in case of an electric transfer and closes it only in emergency configuration.

UGB13131 - U7ST0M0 - UM24DM000000001



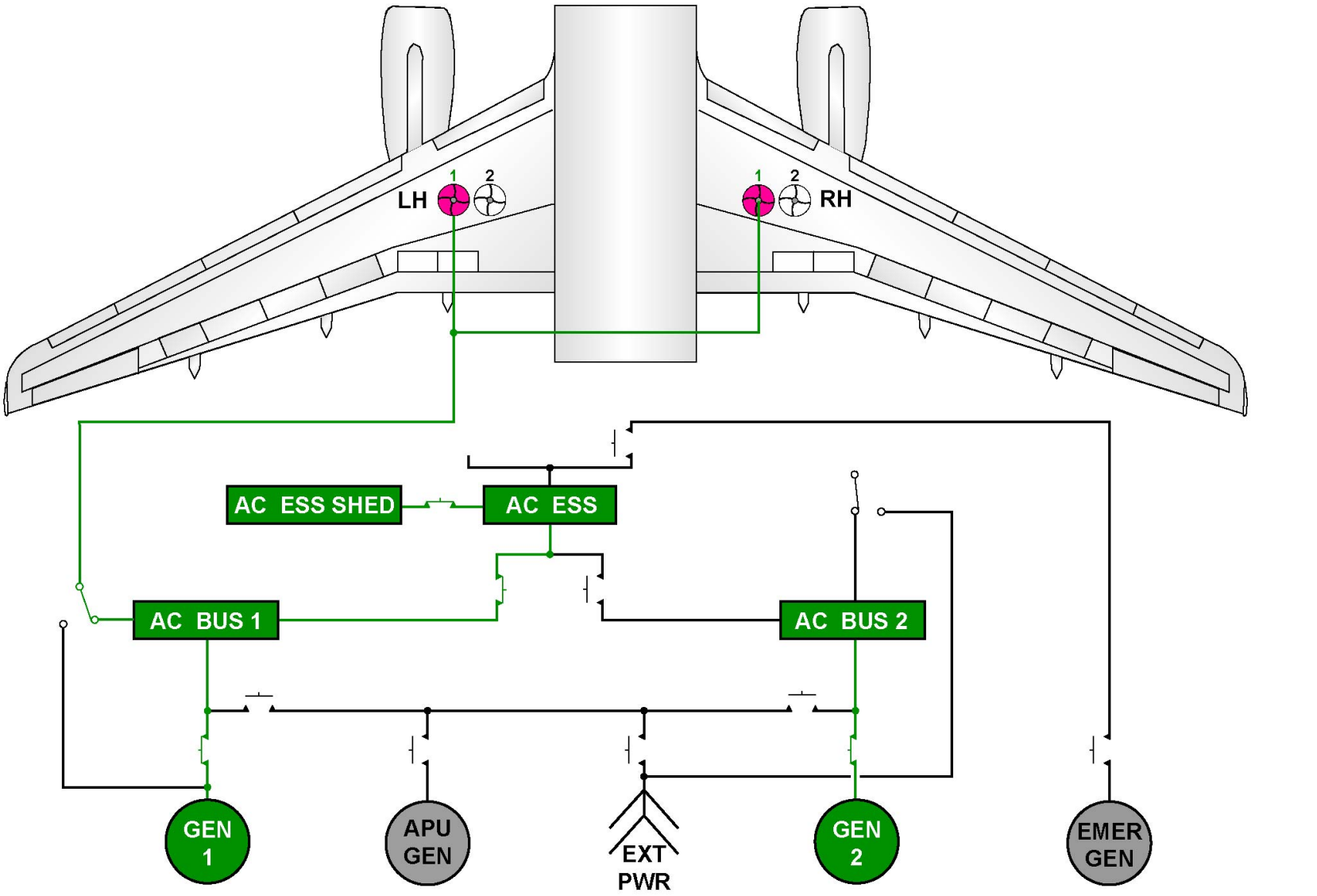
AC BUS 1 AND 2 LOSS

FUEL PUMPS ELEC PWR SUPPLY IN SMOKE CONFIG (3)

NORMAL ELECTRICAL SUPPLY

Here is the normal electrical supply of the wing fuel pumps. Left pump 1 and right pump 1 are supplied by AC BUS 1.

UGB13131 - U7ST0M0 - UM24DN000000001



NORMAL ELECTRICAL SUPPLY

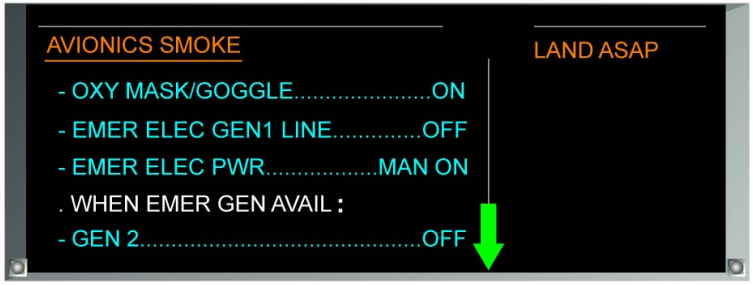
UGB13131 - U7ST0M0 - UM24DN000000001

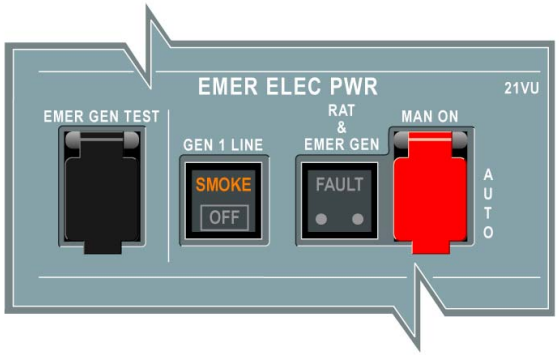
FUEL PUMPS ELEC PWR SUPPLY IN SMOKE CONFIG (3)

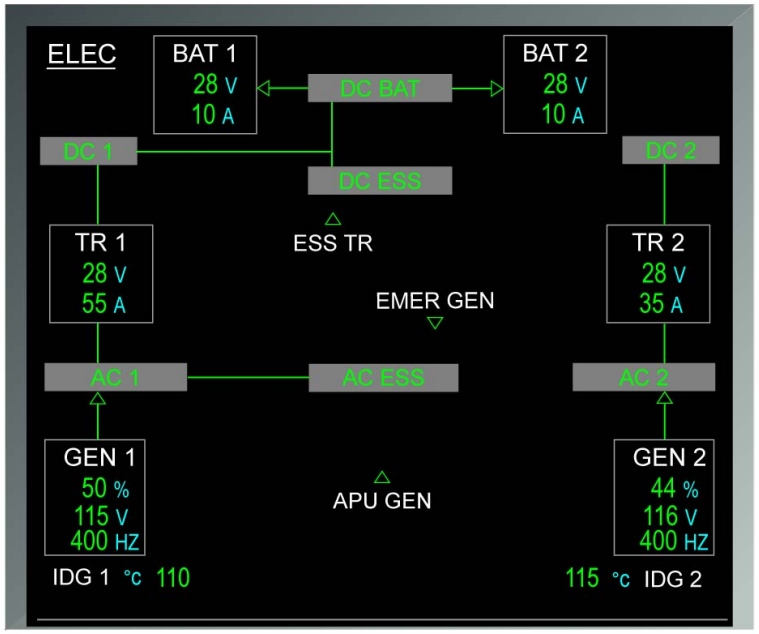
SMOKE WARNING

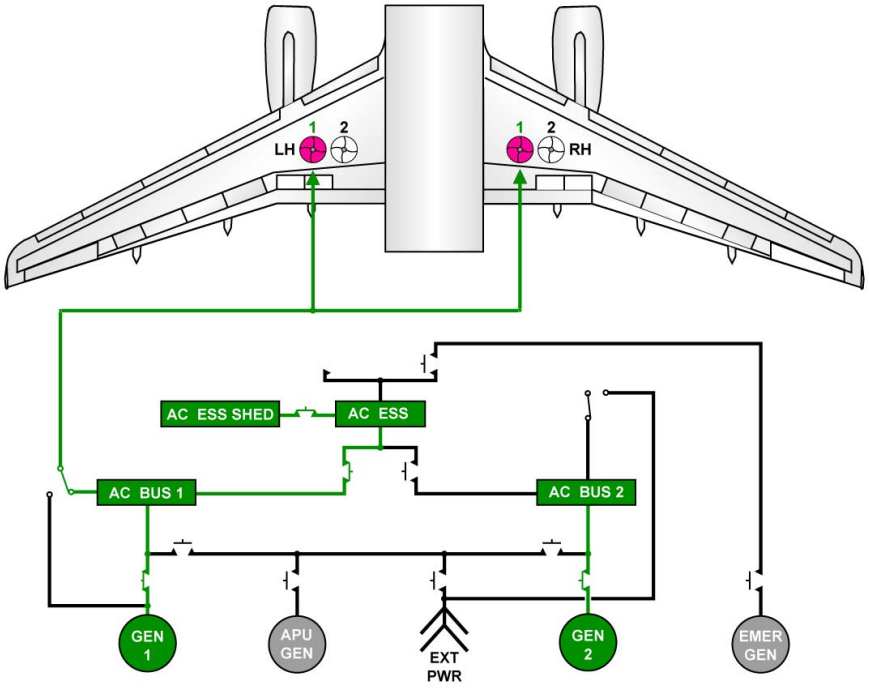
If an avionics smoke warning occurs and smoke is confirmed, GENerator 1 LINE SMOKE P/BSW light comes on amber on the EMERgency ELECtrical PoWeR panel. In this case, several actions have to be taken by the cockpit crew concerning mainly the ventilation and communication systems. If the smoke warning remains 5 min after actions on the ventilation and communication systems, the avionics smoke procedure displayed on ECAM/EWD has to be applied.

UGB13131 - U7ST0M0 - UM24DN000000001









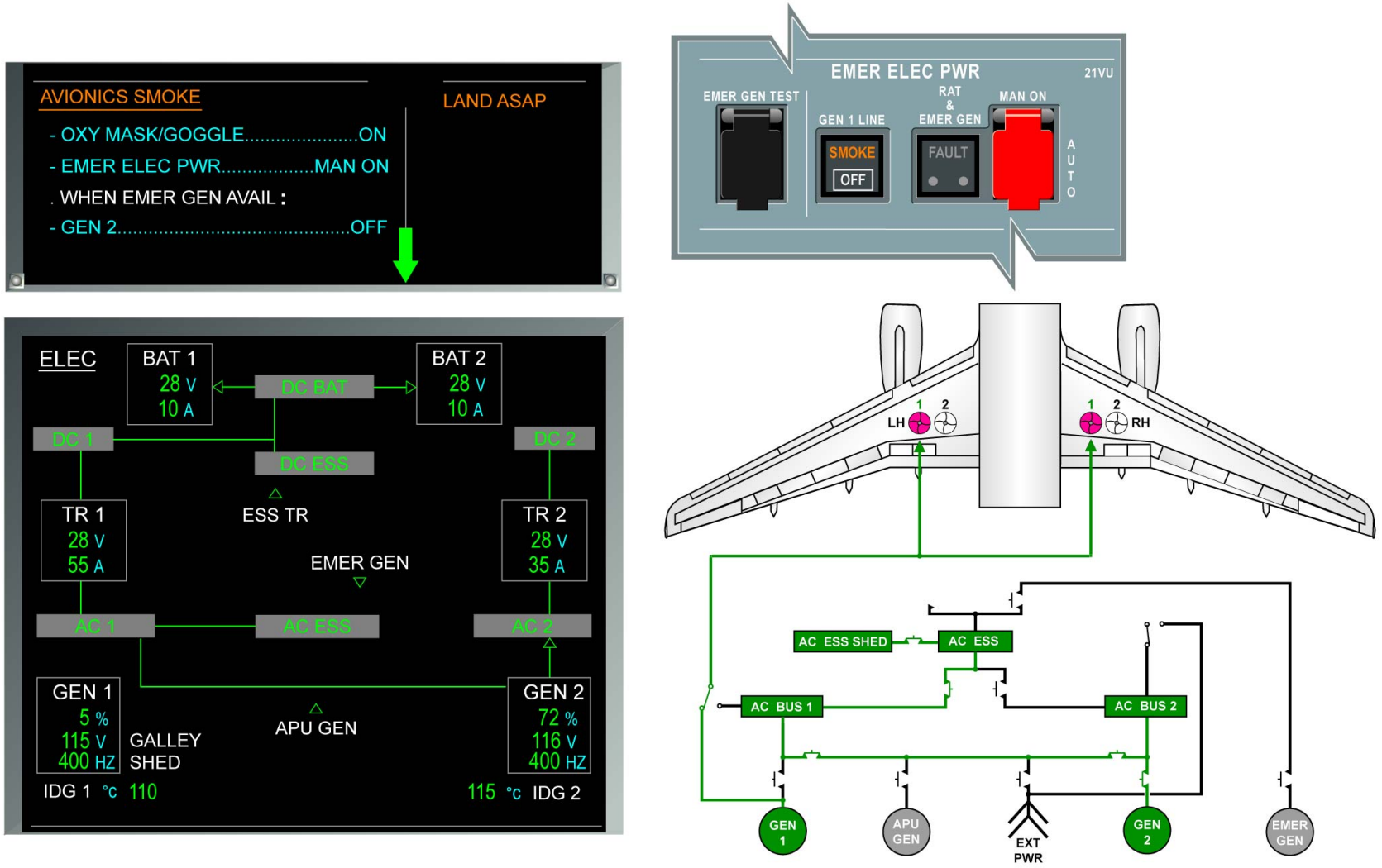
SMOKE WARNING

FUEL PUMPS ELEC PWR SUPPLY IN SMOKE CONFIG (3)

EMER ELEC GEN 1 LINE OFF

In this case, Generator Line Contactor (GLC) 1 opens. Generator 1 remains energized and supplies one fuel pump in each wing tank. AC BUS 1 is supplied by generator 2 through Bus Tie Contactors (BTCs).

UGB13131 - U7ST0M0 - UM24DN000000001



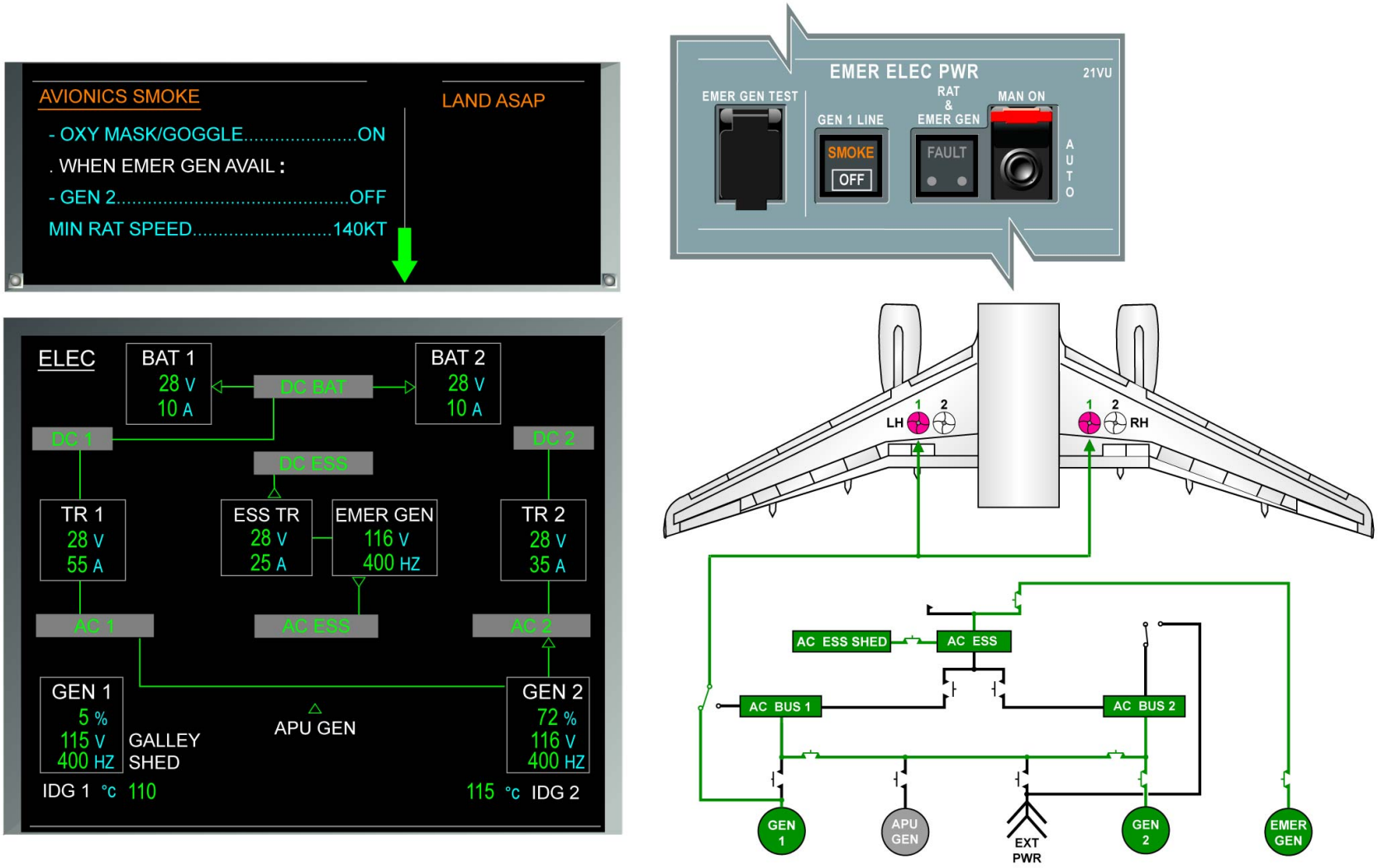
EMER ELEC GEN 1 LINE OFF

FUEL PUMPS ELEC PWR SUPPLY IN SMOKE CONFIG (3)

EMER ELEC PWR MAN ON

In this case, the Ram Air Turbine (RAT) is extended and the emergency generator is connected to the aircraft network by its control unit, when the parameters are correct. The emergency generator then supplies the AC ESSential BUS and DC ESS BUS through ESS Transformer Rectifier (TR).

UGB13131 - U7ST0M0 - UM24DN000000001



EMER ELEC PWR MAN ON

FUEL PUMPS ELEC PWR SUPPLY IN SMOKE CONFIG (3)

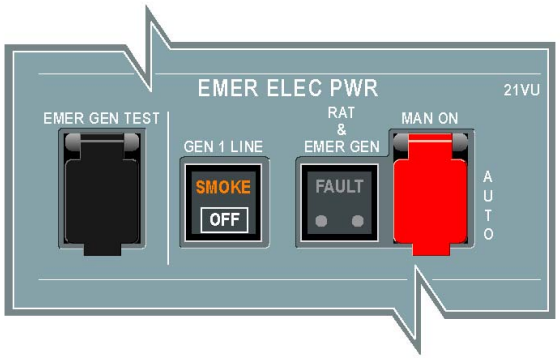
GEN 2 OFF

When the emergency generator is available, the generator 2 P/BSW must be set to OFF.

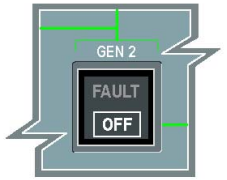
NOTE: Before L/G extension, GEN 2 and EMER ELEC GEN 1 LINE P/BSW must be set to ON.

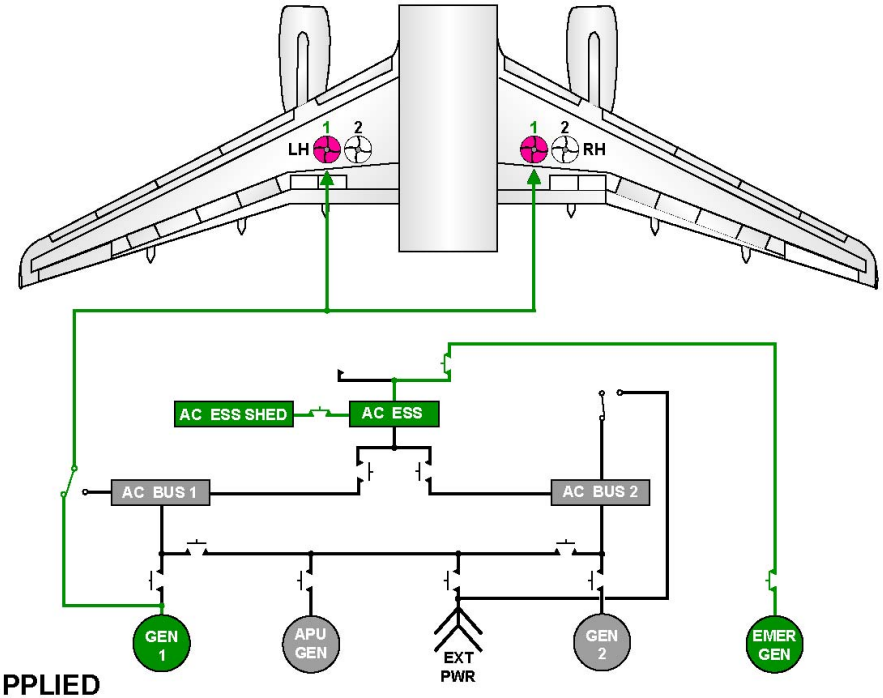
UGB13131 - U7ST0M0 - UM24DN000000001

THE LOWER ECAM DISPLAY UNIT SYSTEM IS NO LONGER SUPPLIED



ELEC PANEL
(35VU)





GEN 2 OFF

AC/DC SHEDDABLE BUS SUPPLY (3)

NORMAL CONFIGURATION

The AC and DC ESSential BUSes supply the AC and DC ESS SHEDdable BUS through the control relays 8XH and 8PH. The open or closed position of the relays 8XH and 8PH changes in relation to the network supply status.

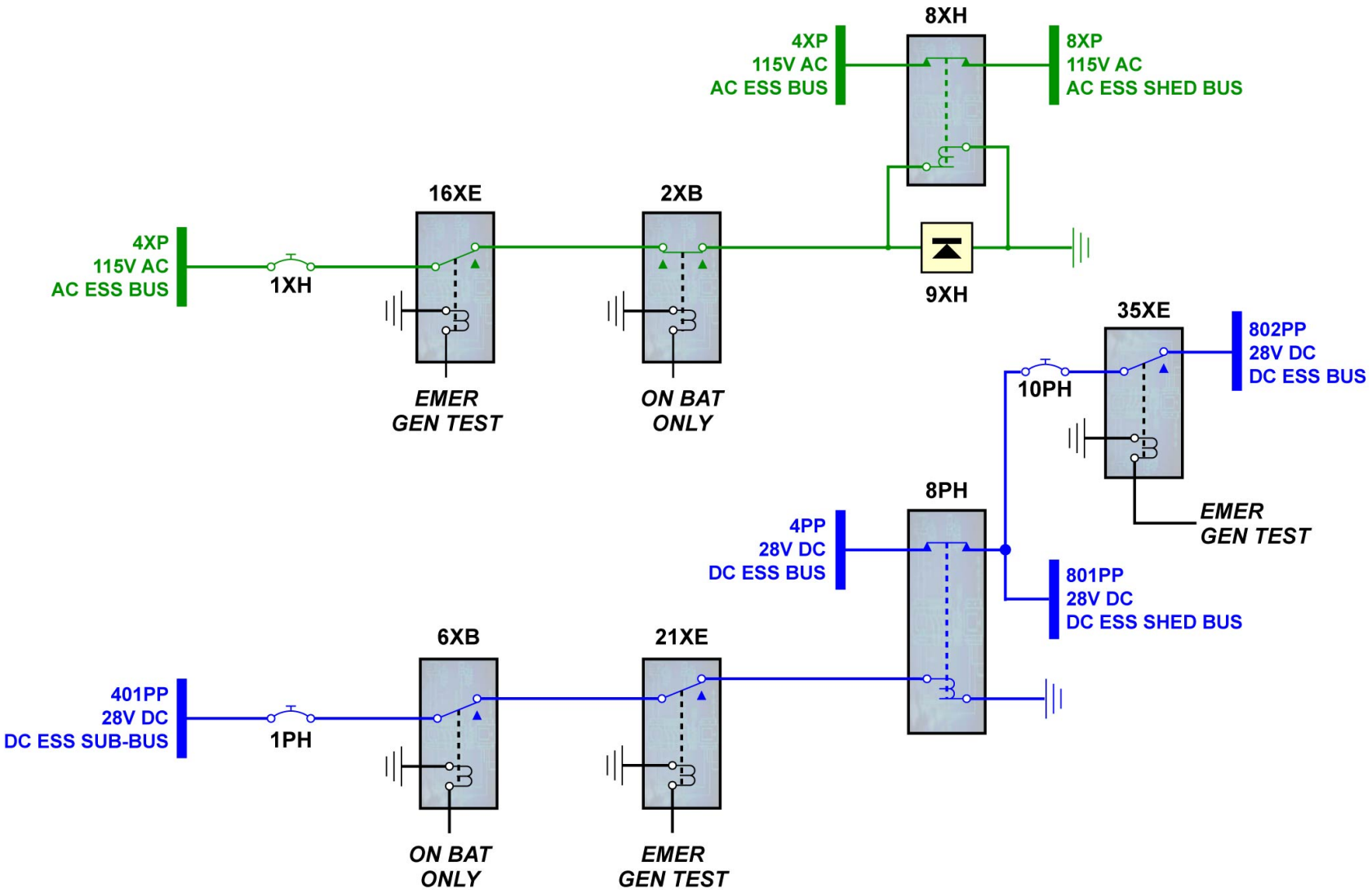
NOTE: The sub-busbar 802PP is shed if the Constant Speed Motor/Generator (CSM/G) is on line and if the forward landing gear is not in the up-locked position.

EMERGENCY CONFIGURATION

If there is an electrical emergency configuration and the Constant Speed Motor Generator (CSM/G) fails, the essential network operates with battery power only. Battery 2 supplies the DC ESS BUS and battery 1 supplies the STATic INVerter (STAT INV), which supplies the AC ESS BUS. In this condition, the AC and DC SHED BUS are not supplied because relays 8XH and 8PH are open due to the fact that BATtery ONLY relays 2XB and 6XB are energized.

NOTE: The AC and DC ESS SHED BUS are also shed during an EMERgency GENerator TEST, because relays 16XE and 21XE are energized.

UGB13131 - U7ST0M0 - UM24DC000000001



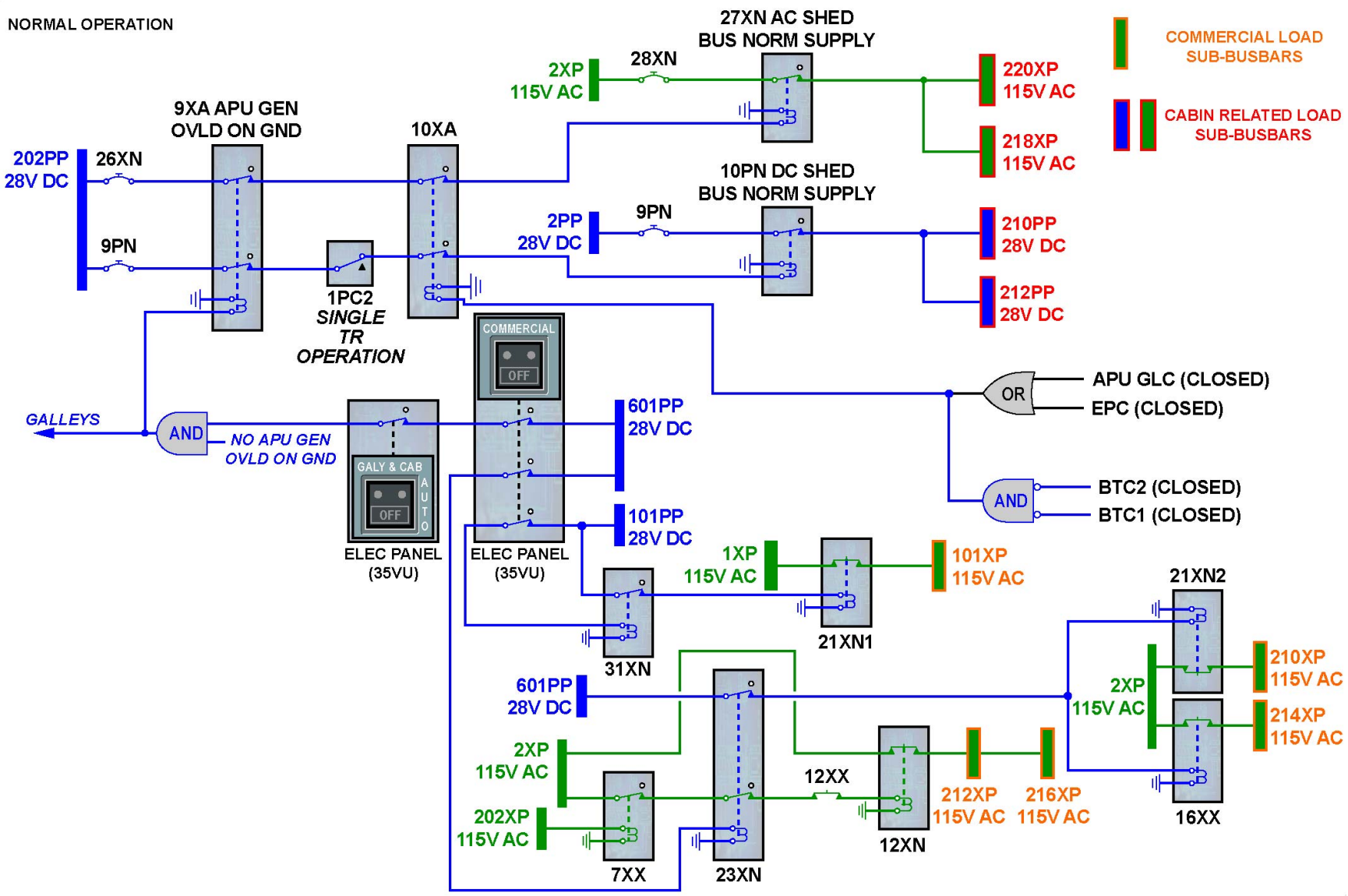
NORMAL CONFIGURATION & EMERGENCY CONFIGURATION

AC/DC SHEDDABLE BUS SUPPLY (3)

GALY & CAB SYS AND COMMERCIAL LOAD

In normal supply configuration (GALleY & CABin and COMMERCIAL P/BSWs pushed in), all the galleys and the cabin and commercial sub-busbars are supplied. When the GALY & CAB P/BSW is set to OFF (OFF legend on) all the galleys and the cabin system sub-busbars (218XP, 220XP,and 210PP, 212PP) are OFF. When the COMMERCIAL P/BSW is set to OFF (OFF legend on) all the galleys and all the sub-busbars are off.

UGB13131 - U7ST0M0 - UM24DC000000001



GALY & CAB SYS AND COMMERCIAL LOAD

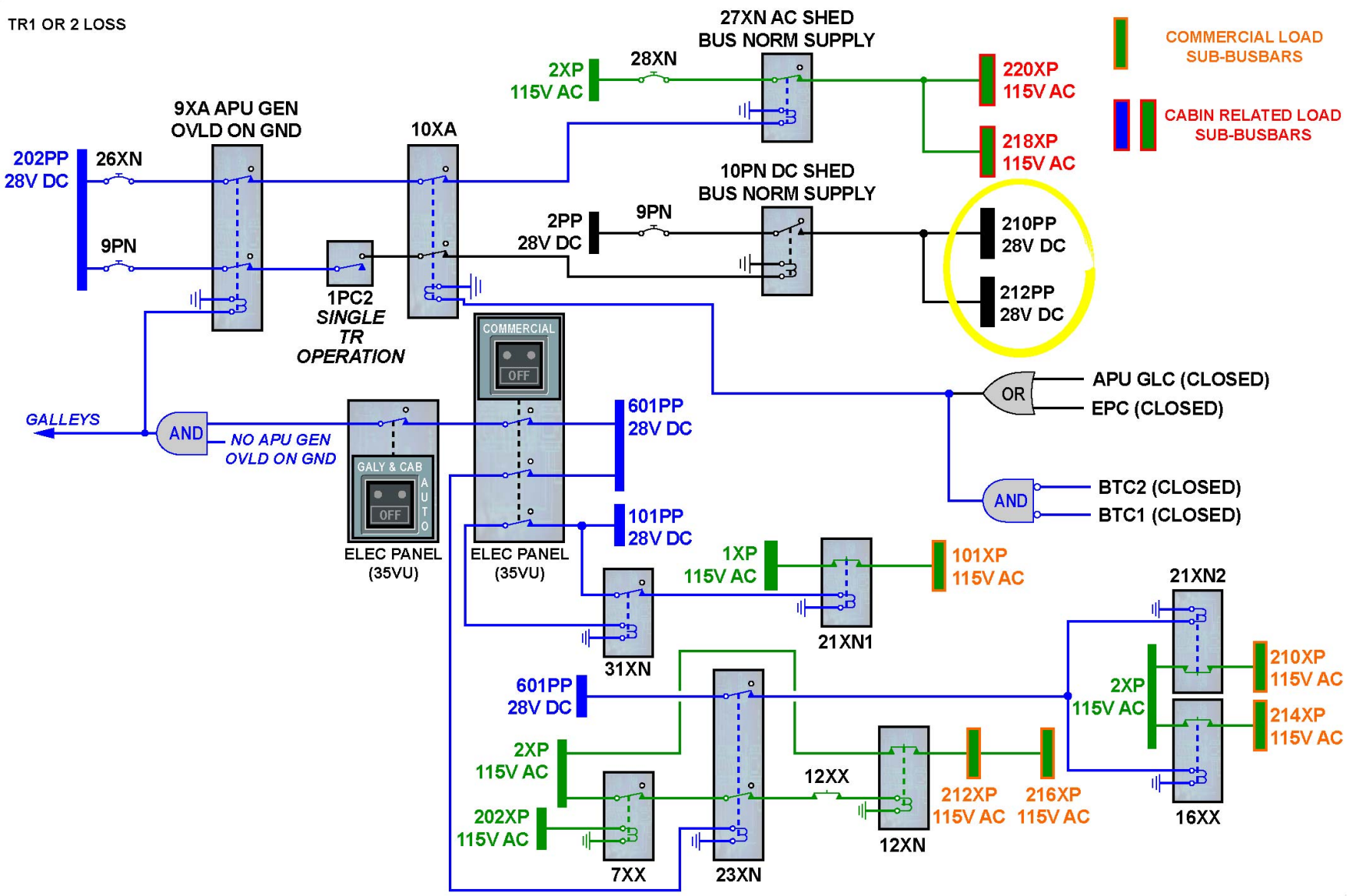
AC/DC SHEDDABLE BUS SUPPLY (3)

GALY & CAB SYS AND COMMERCIAL LOAD (continued)

TR1 or 2 LOSS

GALY & CAB and COMMERCIAL P/BSWs are in normal supply configuration. When Transformer Rectifier (TR) 1 or 2 is lost, relay 1PC2 is energized and the DC sub-busbars 210PP and 212PP are not supplied.

UGB13131 - U7ST0M0 - UM24DC000000001



GALY & CAB SYS AND COMMERCIAL LOAD - TR1 OR 2 LOSS

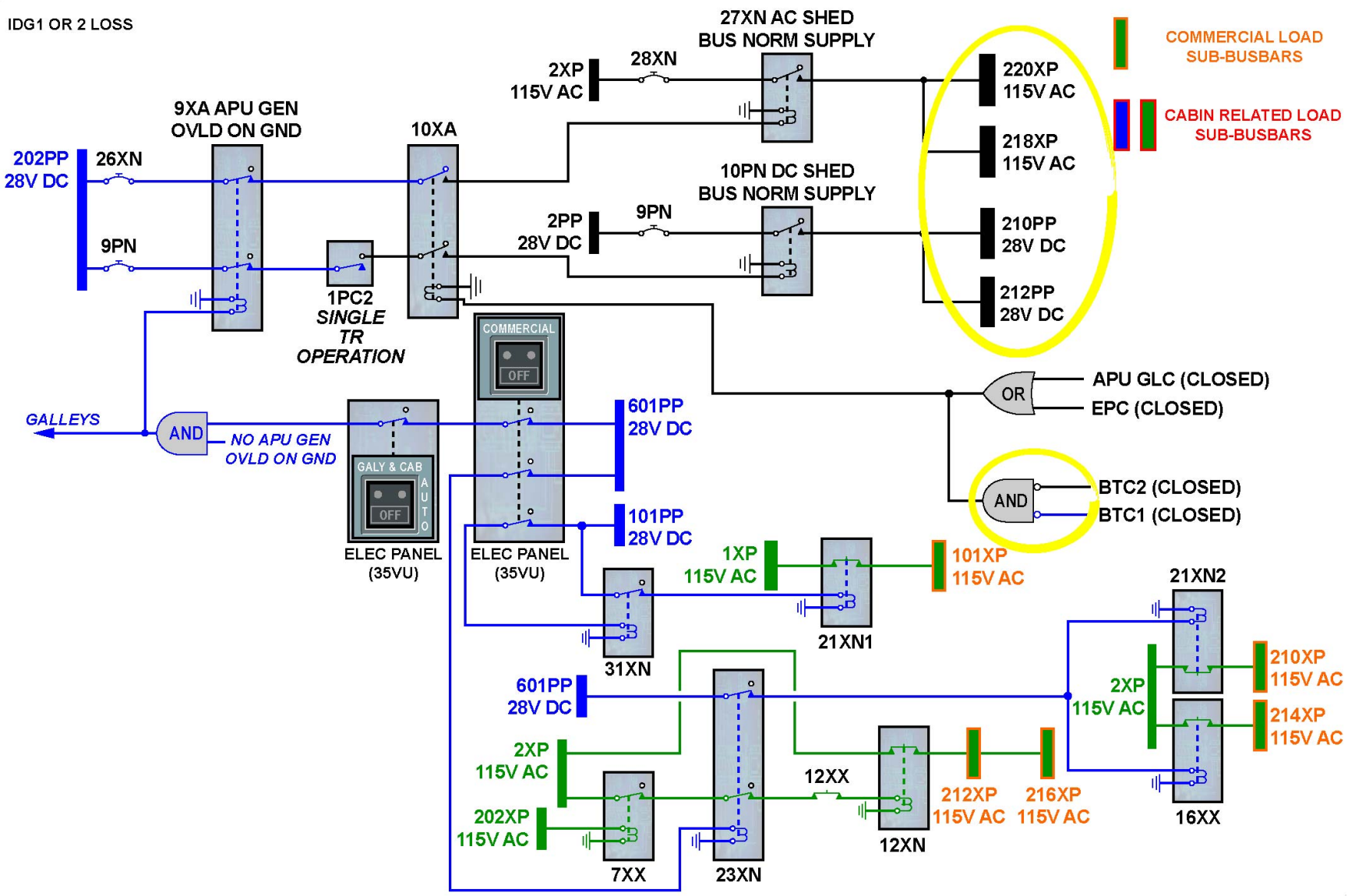
AC/DC SHEDDABLE BUS SUPPLY (3)

GALY & CAB SYS AND COMMERCIAL LOAD (continued)

IDG1 or 2 LOSS

When Integrated Drive Generator (IDG) 1 or 2 is lost, Bus Tie Contactor (BTC) 1 and 2 are closed and relay 10XA is de-energized, this sheds the cabin-related sub-buses. If the APU GEN is lost due to an overload on the ground, all galleys and cabin-related sub-buses are off.

UGB13131 - U7ST0M0 - UM24DC000000001



GALY & CAB SYS AND COMMERCIAL LOAD - IDG1 OR 2 LOSS

REFUELING ON BATTERY (3)

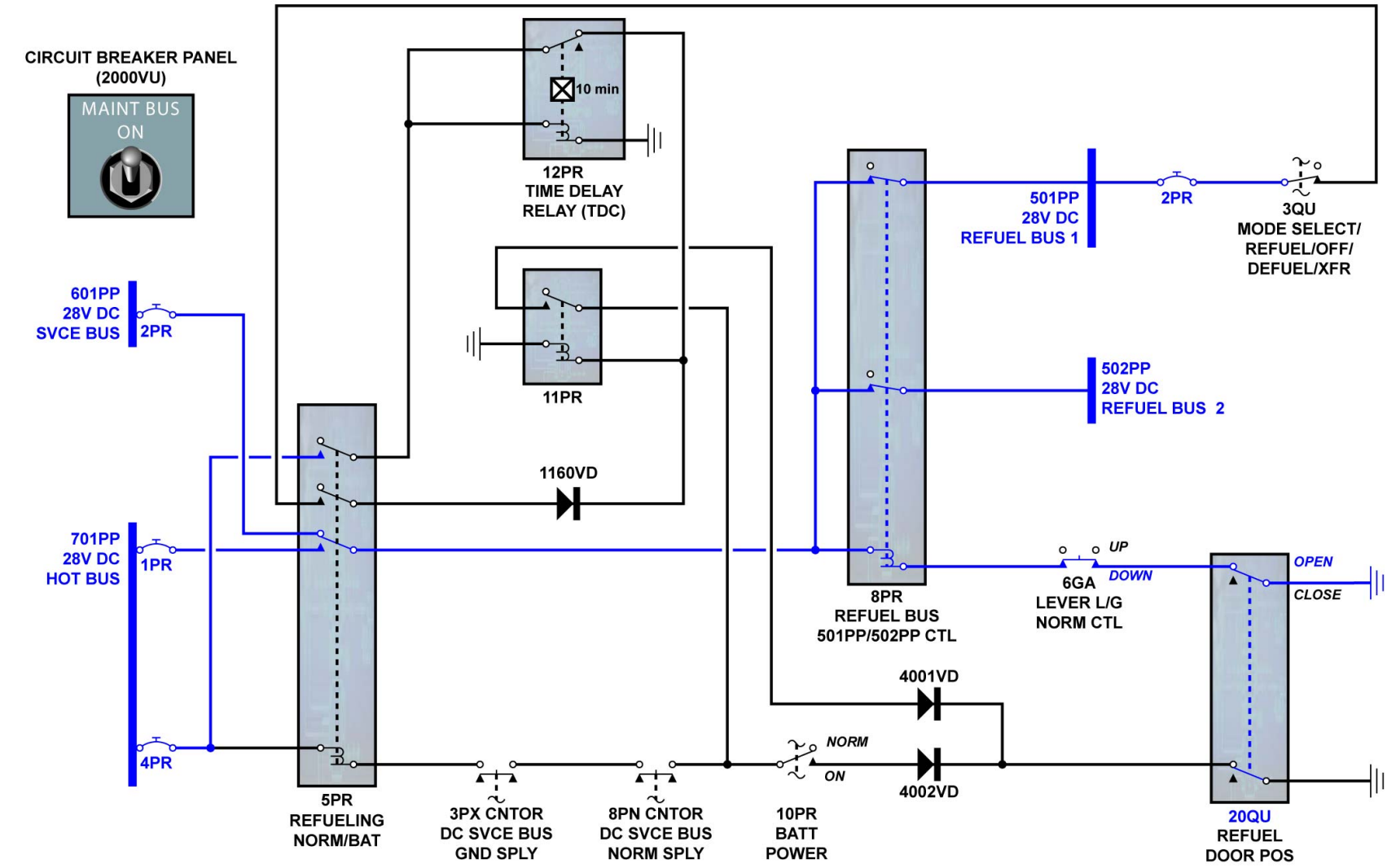
GENERAL

The refueling electrical network is supplied by busbars 501PP and 502PP. It is supplied as soon as the refuel door located on the fuselage below the right wing is opened. Two supplies are then possible:
- 28V DC SerViCE BUS 601PP, supplied from normal network or via MAINTenance BUS switch,
- HOT BUS 701PP if no other power is available.

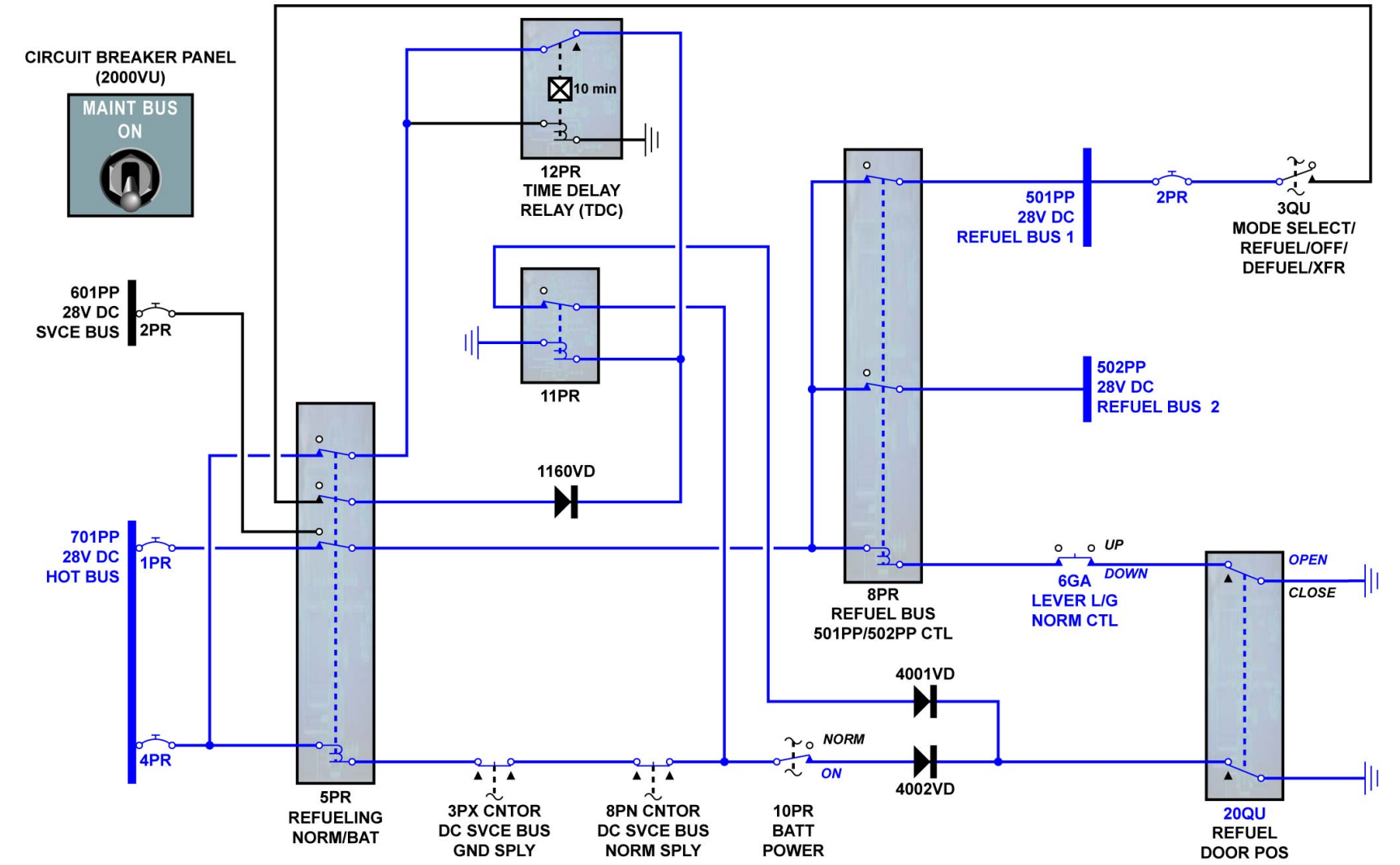
GROUND SERVICE CONFIGURATION

With the services buses supplied, the refuel buses are supplied directly and automatically from the DC service as soon as the refuel panel door is opened.
If the services buses are not supplied, the refuel buses are supplied from the Hot Bus through relays 5PR, 8PR, 11PR and 12PR as soon as the refuel panel door is open and the BATT Power switch is moved to the ON position.

UGB13131 - U7ST0M0 - UM24DO000000001



GENERAL & GROUND SERVICE CONFIGURATION



GENERAL & GROUND SERVICE CONFIGURATION

UGB13131 - U7ST0M0 - UM24DO000000001

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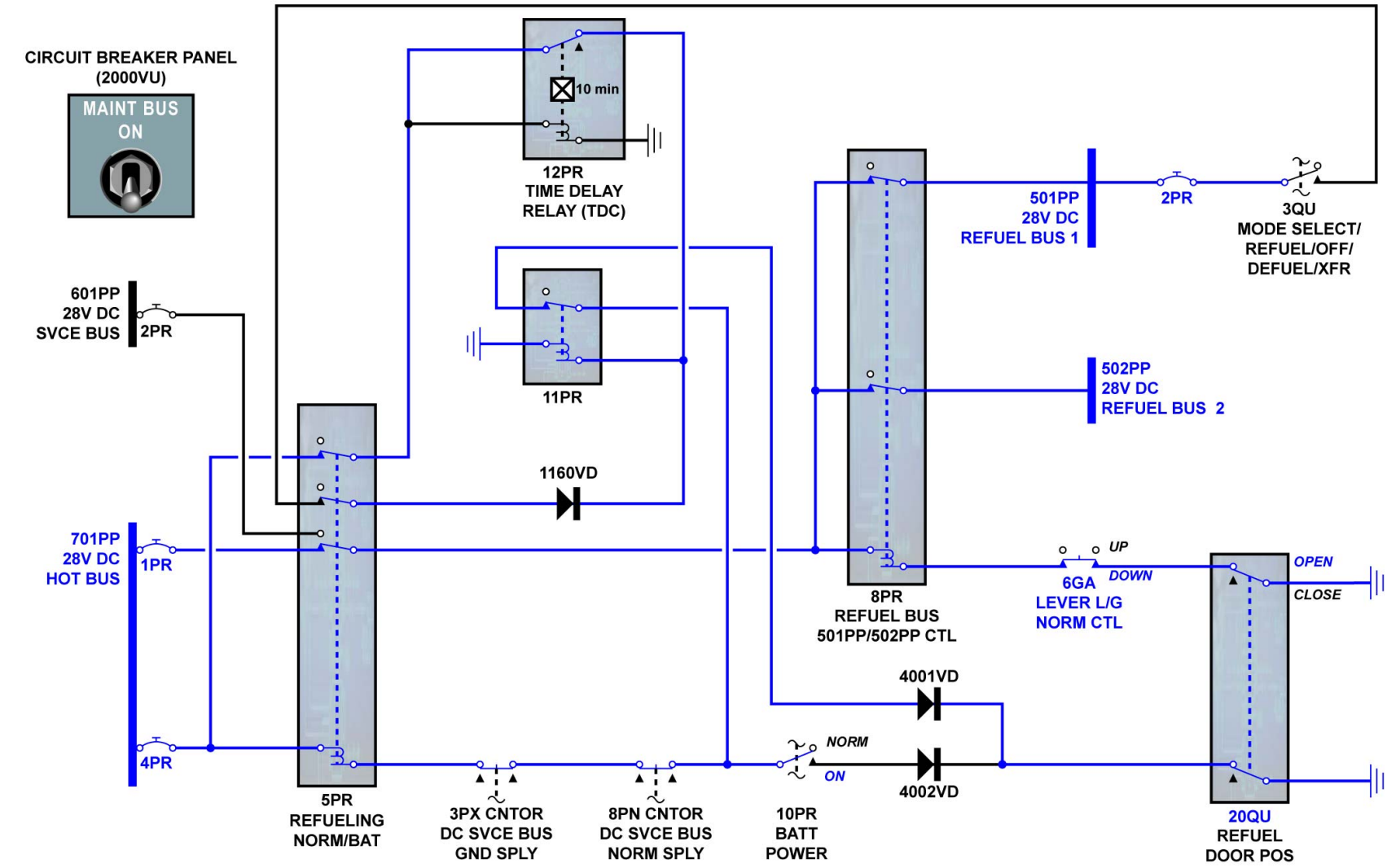
UGB13131 - U7ST0M0 - UM24DO000000001

REFUELING ON BATTERY (3)

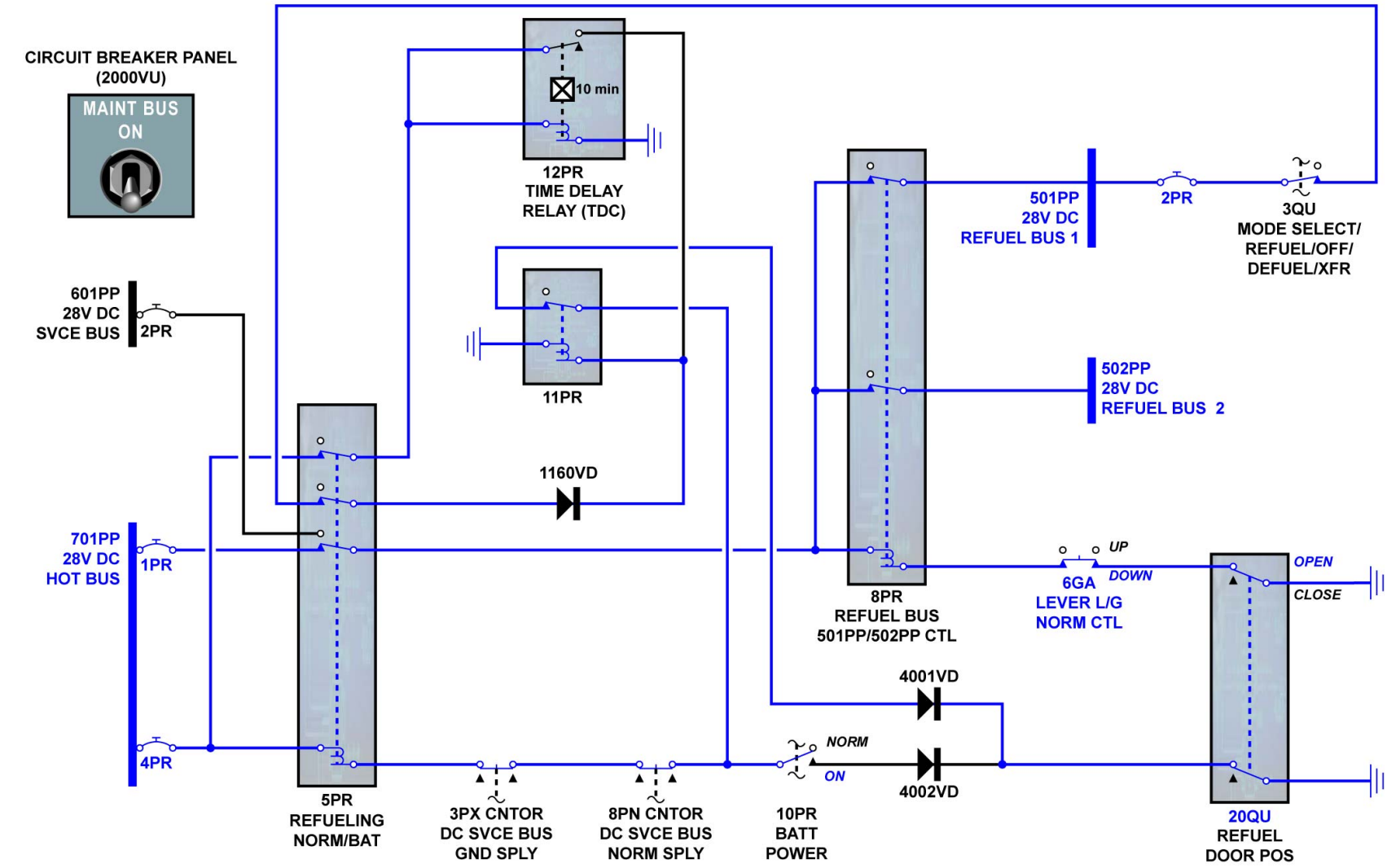
BATTERY ONLY CONFIGURATION

After releasing the BATT Power Switch, relay 12PR will close after 10 minutes.
During these 10 minutes the 12PR keeps the relays 5PR, 8PR, and 11PR energized.
During ten minutes (time delay in the 12 PR relay), the operator may select any position on the mode select switch 3QU.
If the refuel buses are being supplied from the battery hot bus, the operator has 10 minutes from initial power-on in which to select "Refuel or Defuel/XFR". After 10 minutes from initial power-on, the contacts in relay 12PR will move to the energized position. If the Mode Select switch is in the "OFF" position the power supply from the batteries will be disconnected automatically.
If the operator does not switch off the refueling system, the relay 12PR will cut off battery power supply to the refuel buses.

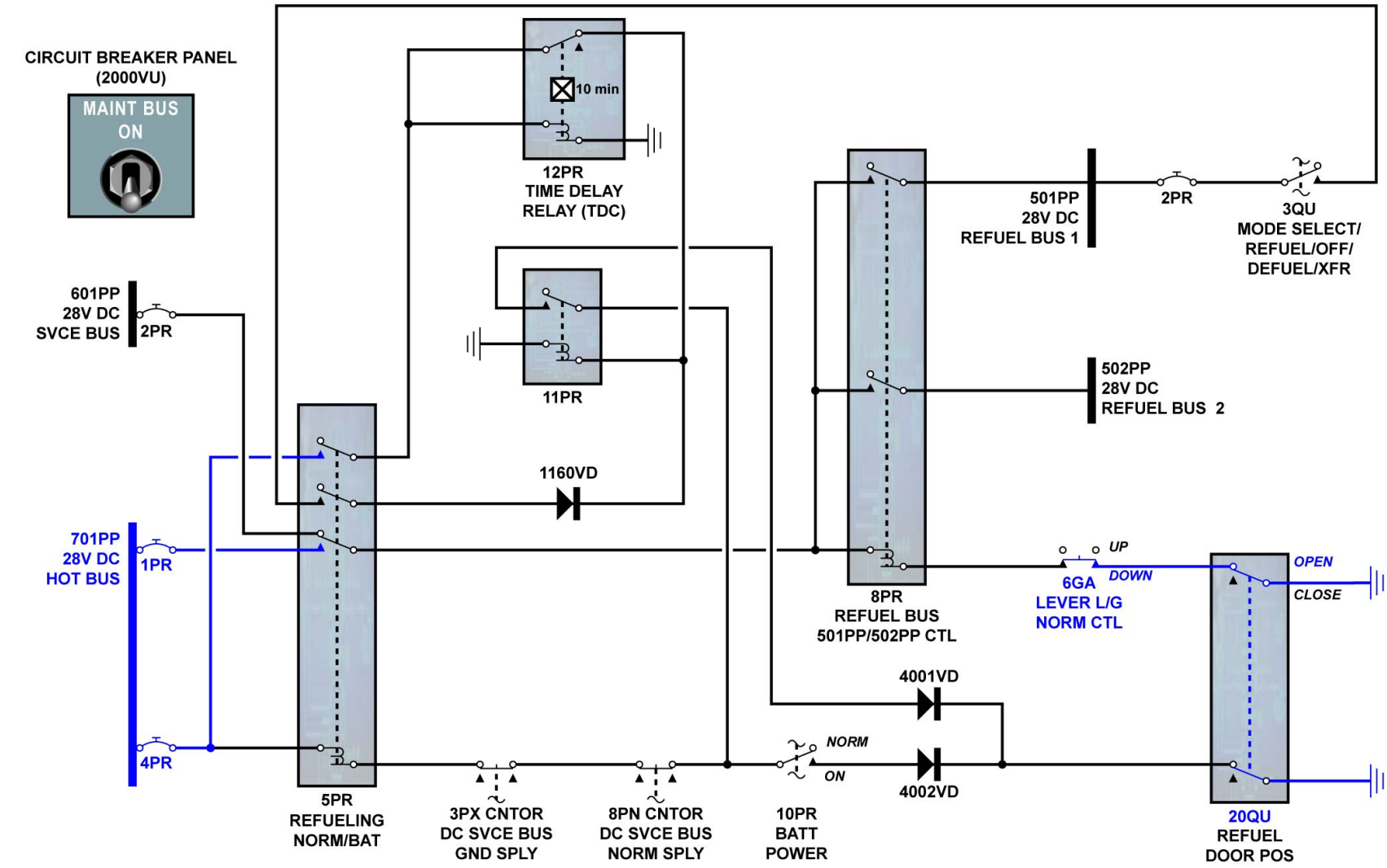
UGB13131 - U7ST0M0 - UM24DO000000001



BATTERY ONLY CONFIGURATION



BATTERY ONLY CONFIGURATION



BATTERY ONLY CONFIGURATION

UGB13131 - U7ST0M0 - UM24DO000000001

DC MAIN GENERATION D/O (3)

tr

There are three identical Transformer Rectifiers (TRs): TR 1, TR 2 and ESSential TR, each with 200 A output current in continuous operation. Each TR converts the three phase AC into 28V DC.

batteries

There are two identical nickel-cadmium batteries of 20 cells each. If the battery voltage is below 26.5V DC, when no other electrical source is available, a charging cycle is needed by setting the BATtery P/B to ON and supplying the DC normal network to permit changing. The nominal capacity of each battery is 23 Ah.

distribution

TR 1, powered from AC BUS 1, supplies DC BUS 1 and DC BAT BUS. TR 2, powered from AC BUS 2, supplies DC BUS 2. The ESS TR is either supplied from the AC ESS BUS or the EMERgency GENerator. It can supply the DC ESS BUS and the DC SHEDdable ESS BUS when required. The two batteries are connected to the DC BAT BUS. BAT 1 can also supply the STATic INVerter and BAT 2 can supply the DC ESS BUS.

tr operation

The TRs start to operate as soon as they are supplied by the associated AC busbar. Automatic switching is provided in case of TR 1 or TR 2 failure to guarantee power supply to all affected DC busbars.

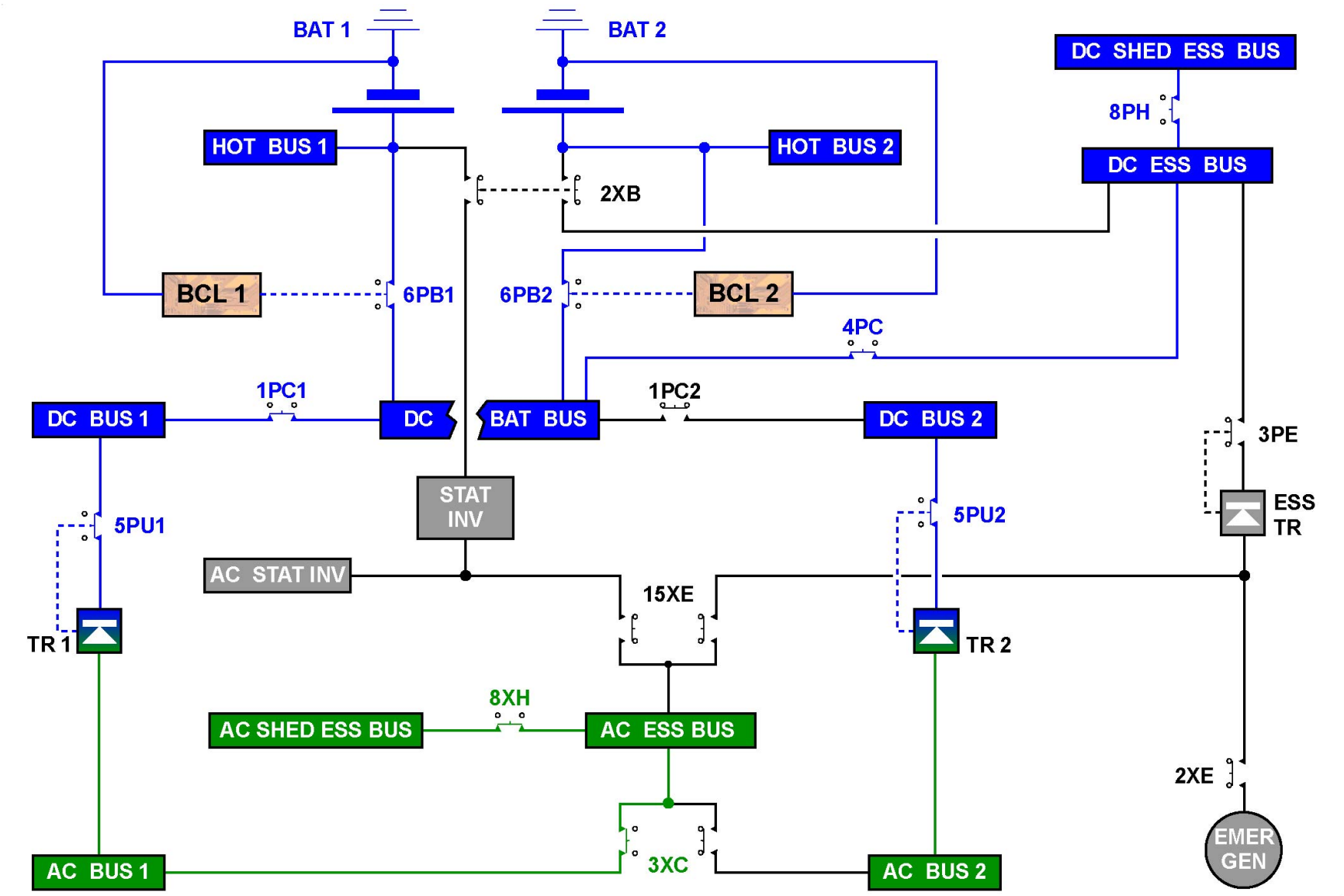
battery operation

BAT 1 and BAT 2 are charged from DC BAT BUS through contactors. These contactors are controlled by the Battery Charge Limiters (BCLs).

bcL functions

Each BCL controls its battery contactor. The BCLs are identical and interchangeable. The battery contactors are controlled in order to:
- ensure automatic battery connection for charging,
- protect the battery against thermal runaway and short-circuit,
- prevent complete discharging when the aircraft is on the ground.

UGB13131 - U7ST0M0 - UM24DP000000001



TR ... BCL FUNCTIONS

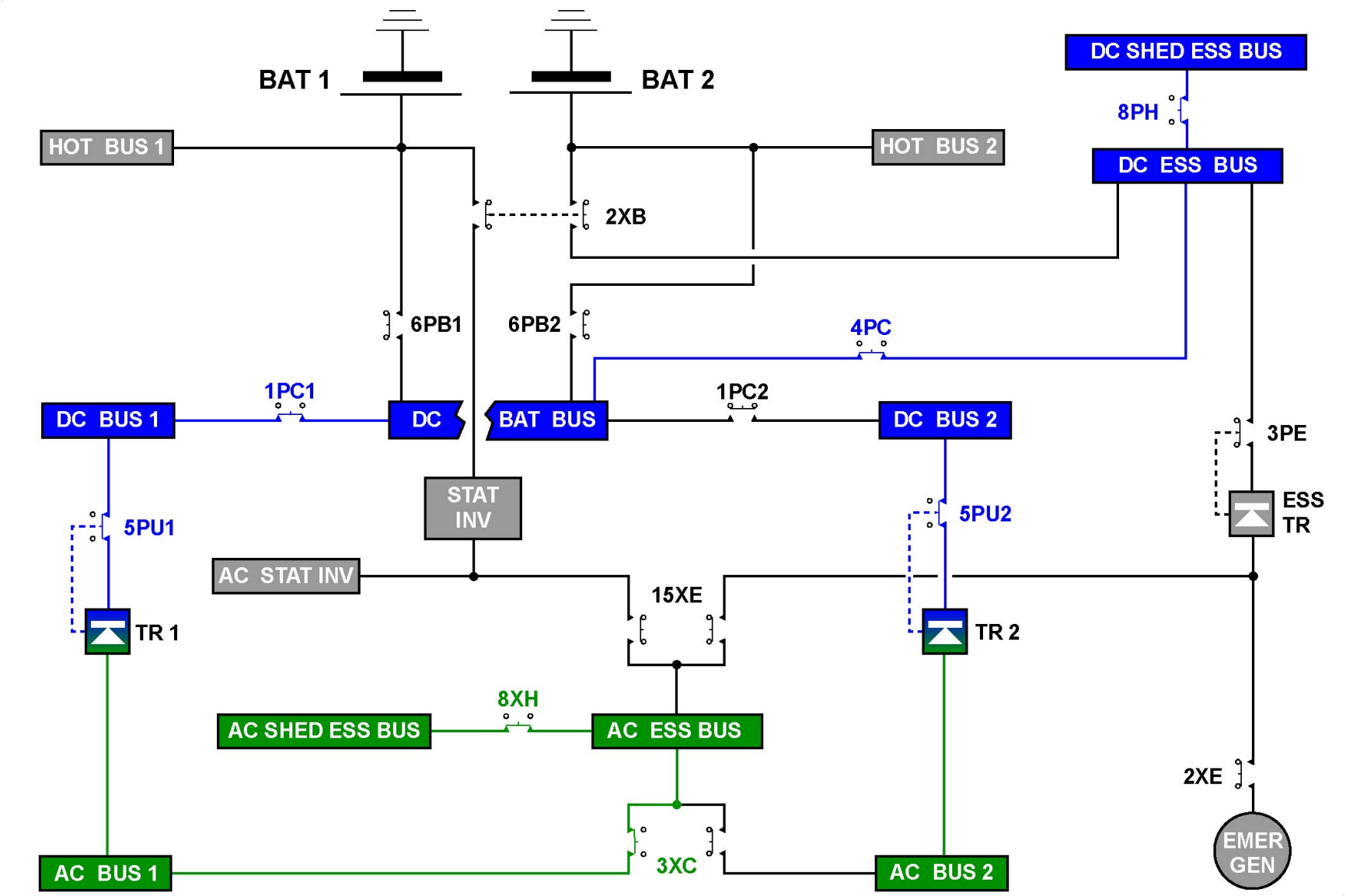
UGB13131 - U7ST0M0 - UM24DP000000001

DC NORMAL/ESSENTIAL GENERATION SWTG D/O (3)

normal configuration

In normal configuration, Transformer Rectifier (TR) 1 supplies successively DC BUS 1, DC BATtery BUS, DC ESSential BUS and DC ESS SHEDdable BUS. TR 2 supplies only DC BUS 2.

UGB13131 - U7ST0M0 - UM24DQ000000001



NORMAL CONFIGURATION

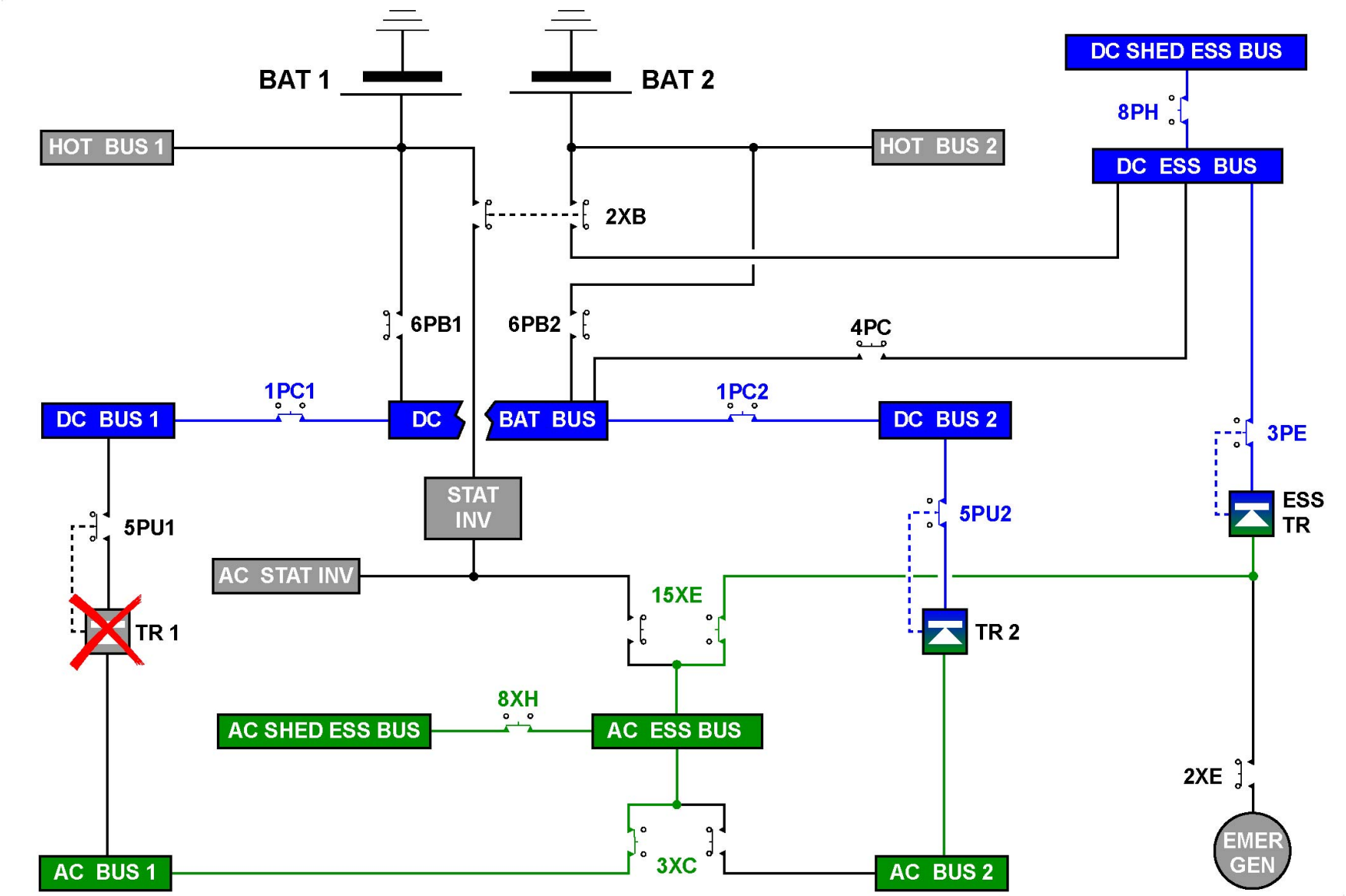
UGB13131 - U7ST0M0 - UM24DQ000000001

DC NORMAL/ESSENTIAL GENERATION SWTG D/O (3)

tr 1 loss

If TR 1 fails, TR 2 automatically supplies DC BAT BUS and DC BUS 1 through DC BUS 2. The DC ESS BUS supply is automatically transferred from DC BAT BUS to AC ESS BUS through the ESS TR.

UGB13131 - U7ST0M0 - UM24DQ000000001



TR 1 LOSS

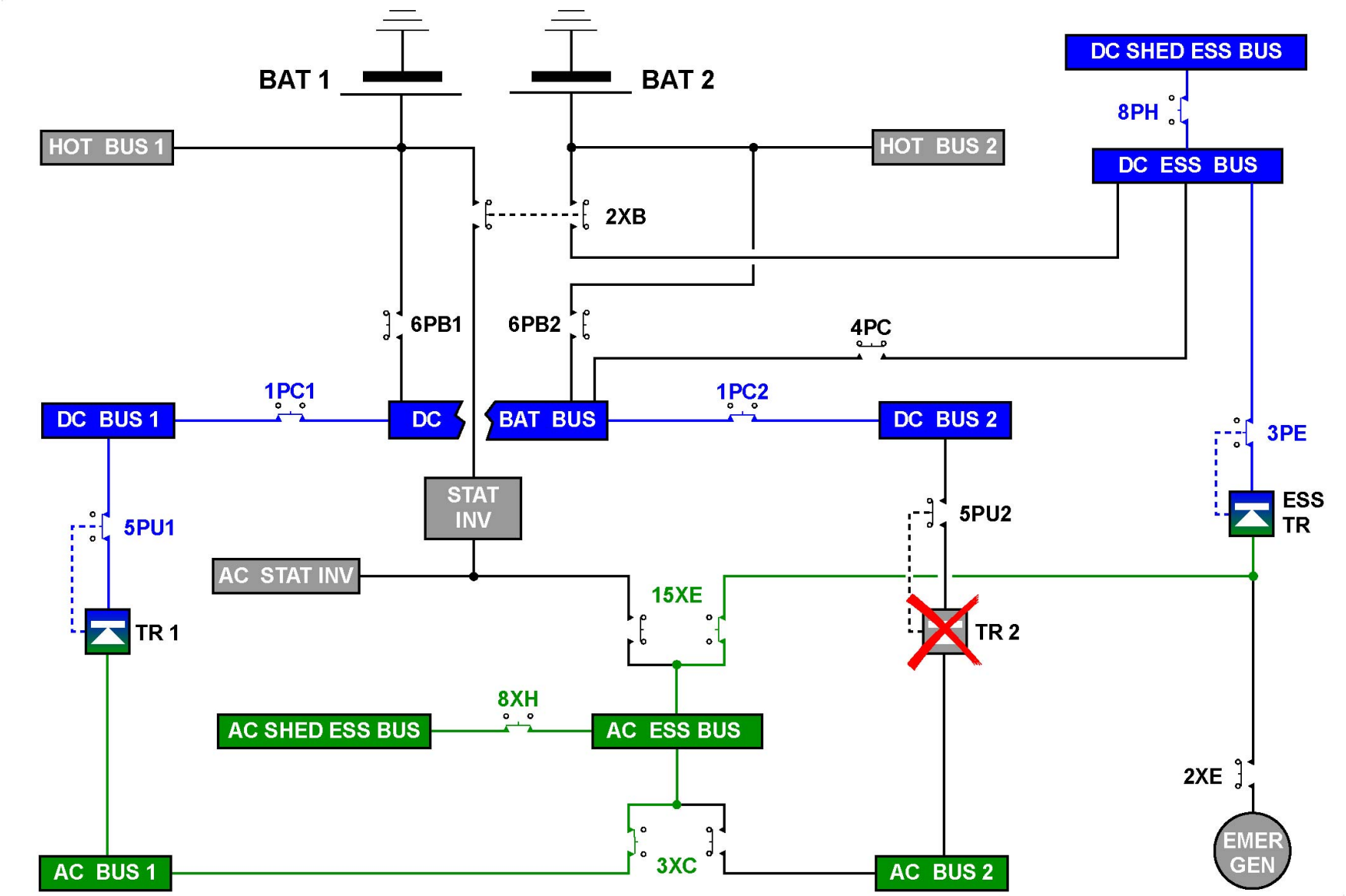
UGB13131 - U7ST0M0 - UM24DQ000000001

DC NORMAL/ESSENTIAL GENERATION SWTG D/O (3)

TR 2 loss

If TR 2 fails, TR 1 automatically supplies DC BUS 2 through DC BUS 1 and DC BAT BUS. The DC ESS BUS supply is automatically transferred from DC BAT BUS to AC ESS BUS through the ESS TR.

UGB13131 - U7ST0M0 - UM24DQ000000001



TR 2 LOSS

UGB13131 - U7ST0M0 - UM24DQ000000001

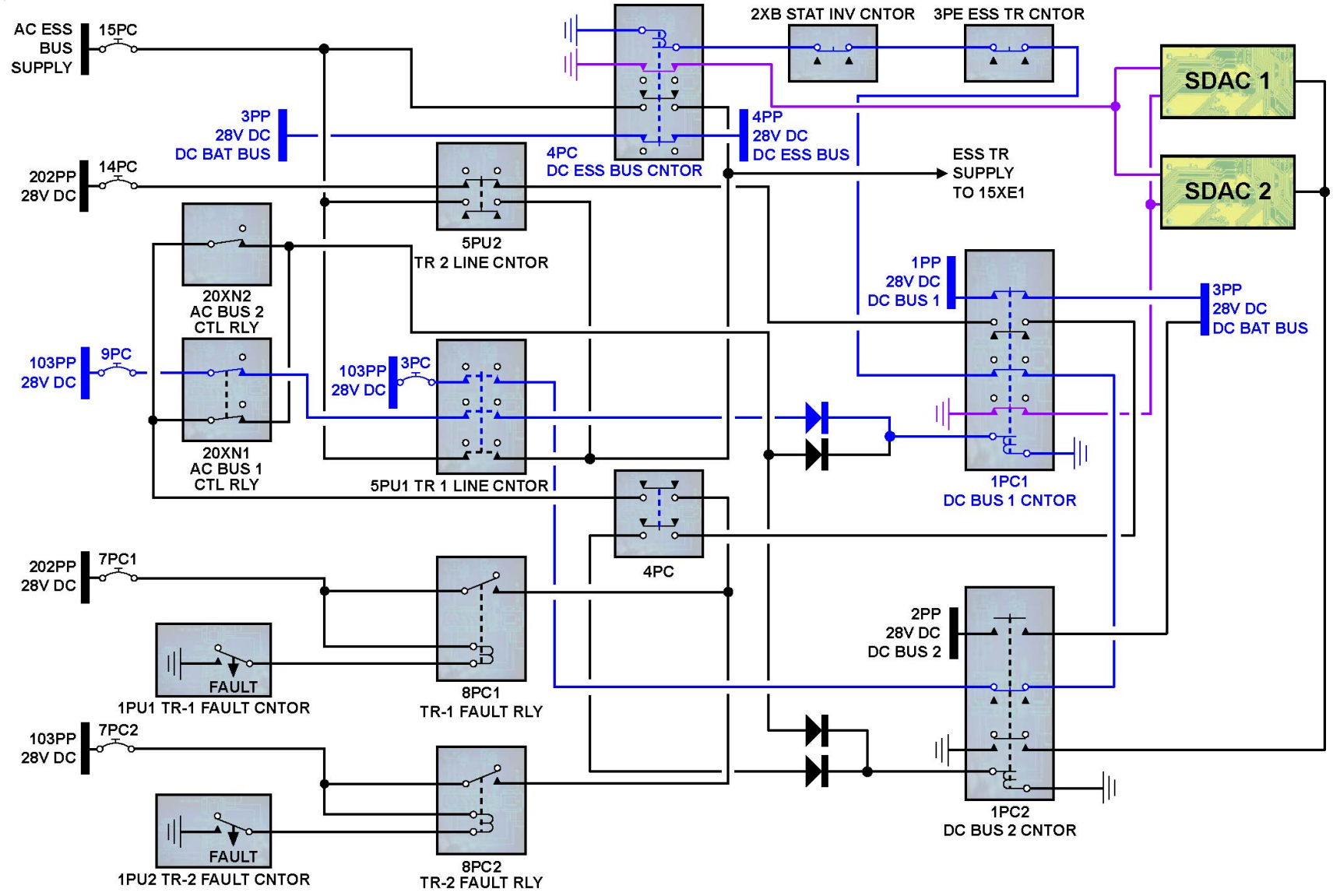
DC NORMAL/ESSENTIAL GENERATION SWTG ELEC (3)

normal configuration

These circuits control the supply of DC normal busbars and DC ESSential BUS. They enable:
- their normal supply in normal flight configuration,
- automatic transfer in some failure conditions.

In normal configuration, AC BUS 1 and AC BUS 2 are supplied, so their respective control relays 20XN1 and 20XN2 are closed. In addition, Transformer Rectifiers (TRs) 1 and 2 being operational, their respective line contactors 5PU1 and 5PU2 are closed. This enables DC sub-busbar 103PP to supply the DC BUS 1 contactor 1PC1. Its closure allows the connection between DC BUS 1 and DC BATtery BUS.

UGB13131 - U7ST0M0 - UM24O3000000001



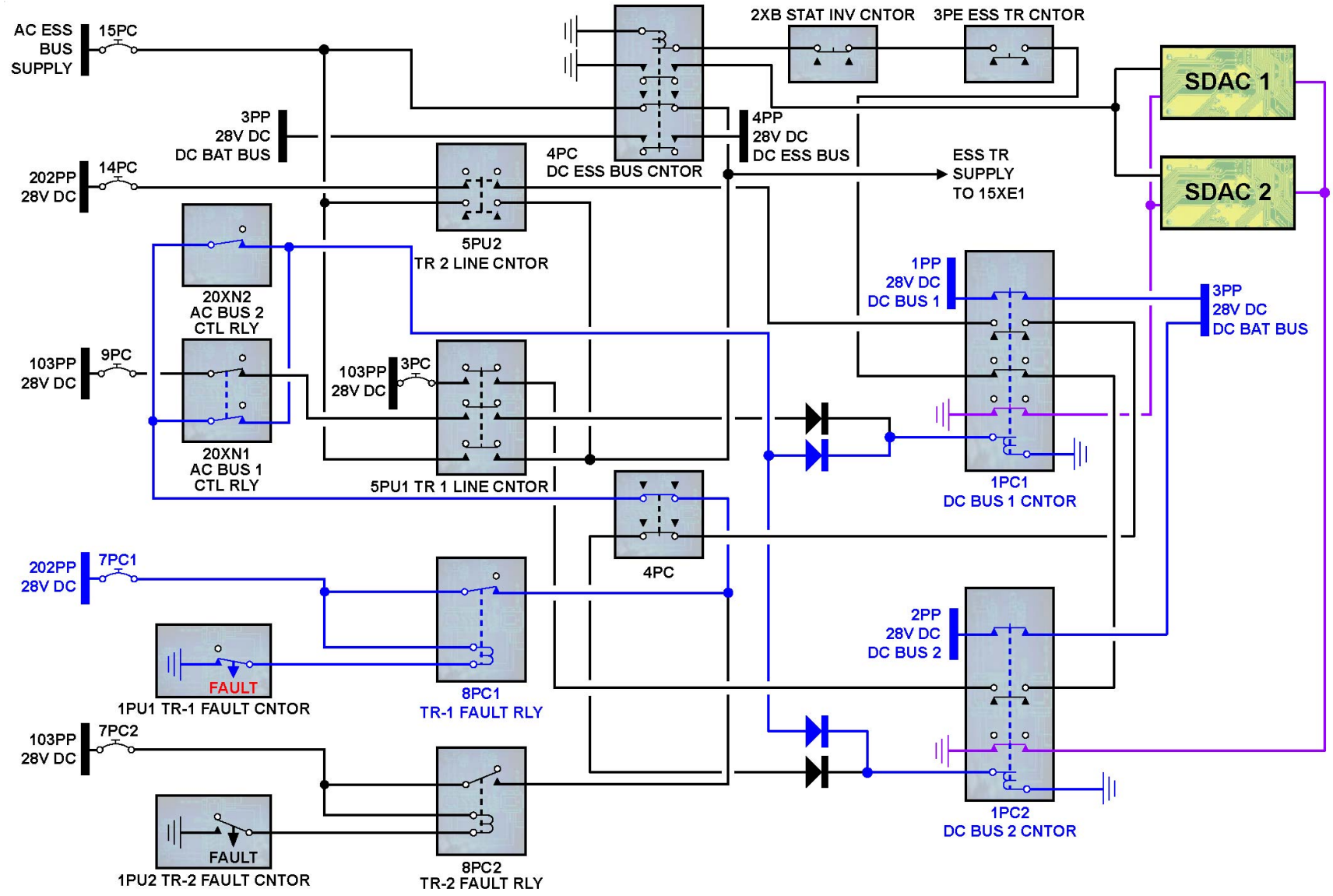
NORMAL CONFIGURATION

DC NORMAL/ESSENTIAL GENERATION SWTG ELEC (3)

tr 1 or tr 2 loss

In case of TR 1 loss, as shown on the graphic, the TR 1 line contactor 5PU1 opens and DC BUS 1 contactor 1PC1 is no longer supplied by sub-busbar 103PP. In the same time, the TR 1 FAULT CoNTactOR 1PU1 closes allowing the DC sub-busbar 202PP to supply relay 8PC1. AC BUS control relays 20XN1 and 20XN2 still being closed, DC BUS contactors 1PC1 and 1PC2 are now supplied by sub-busbar 202PP and close. DC BUS 1, DC BAT BUS and DC BUS 2 are then connected together.

UGB13131 - U7ST0M0 - UM24O3000000001



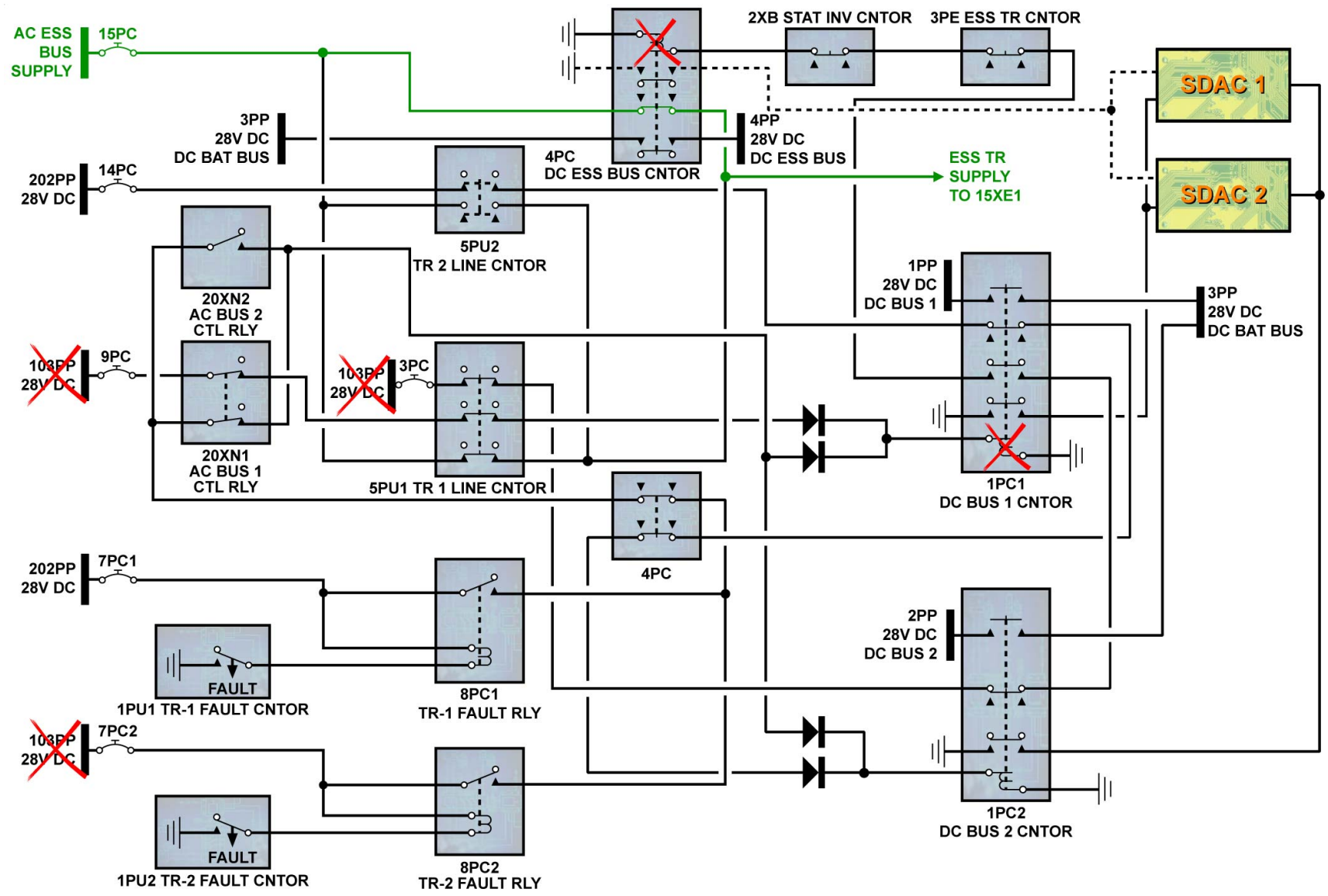
TR 1 OR TR 2 LOSS

DC NORMAL/ESSENTIAL GENERATION SWTG ELEC (3)

LOSS OF DC ESS SUPPLY

In the event of a DC ESS BUS supply failure, loss of TR1 or 1PC1 or 4PC, the DC ESS BUS supply is recovered from the ESS TR. The fault information is received by the System Data Acquisition Concentrator (SDAC), which will initiate the display of the DC BUS TIE class 2 failure message on the ECAM status page.

UGB13131 - U7ST0M0 - UM24O3000000001



LOSS OF DC ESS SUPPLY

TRANSFORMER RECTIFIER D/O (3)

GENERAL

Three identical Transformer Rectifiers (TRs) are fitted on the aircraft. They operate as soon as they are supplied. The TRs are supplied with three phase 115V AC/400 Hz, the DC output voltage for each TR is 28V DC at 200 A. Each TR controls its contactor via an internal logic.

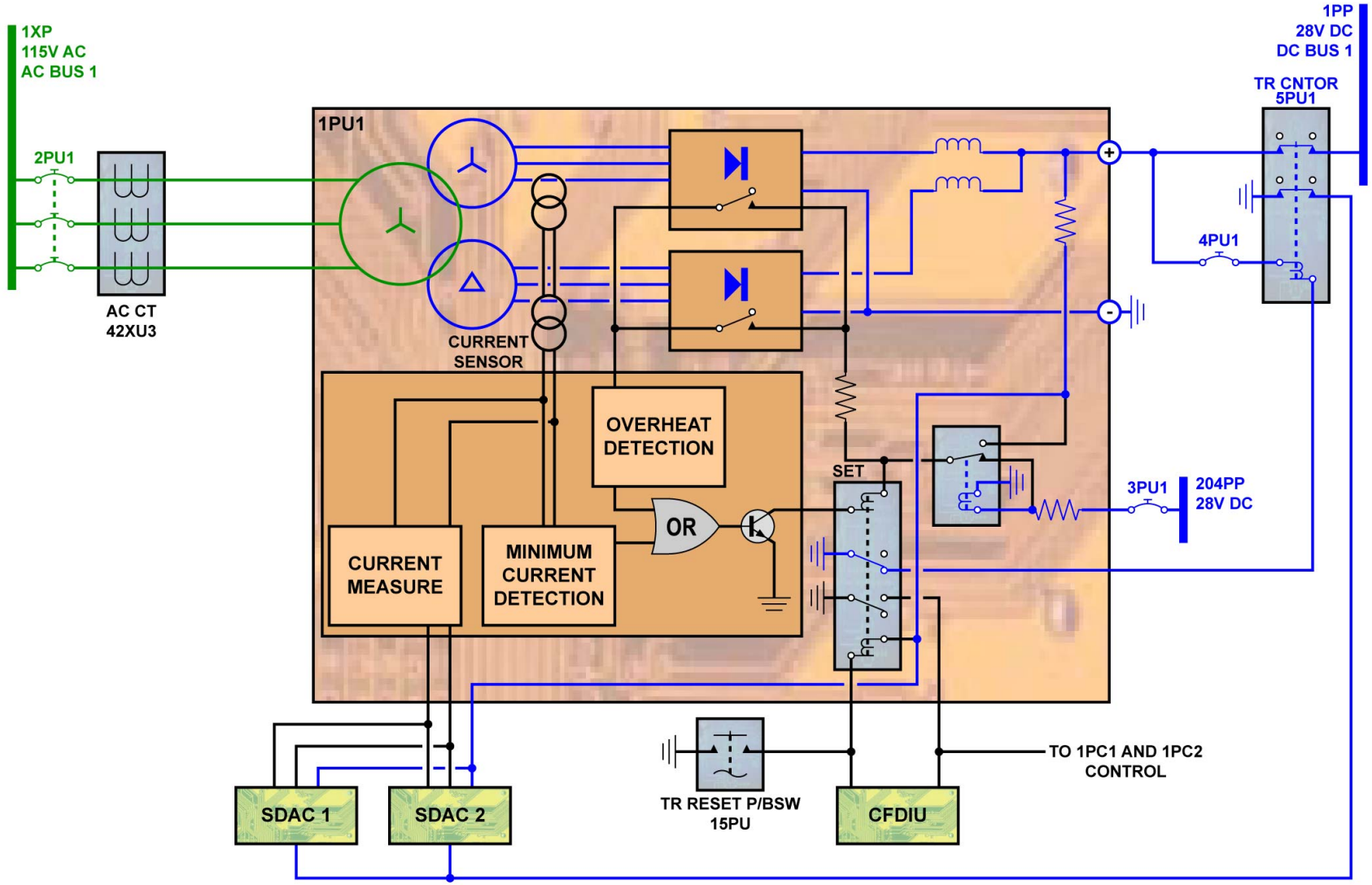
TR PROTECTION

Each TR control logic consists of an overheat protection and a minimum current flow detection to isolate the distribution circuit from the TR.

TR 1 NORMAL CONFIGURATION

As soon as AC BUS 1 is supplied, the TR 1 output is delivered to the DC BUS 1 through TR contactor (5PU1), which is energized when no TR protection is active. The protection module is supplied by DC sub-busbar 204PP. To reset the TR, the TR ReSeT P/BSW 15PU has to be pushed. The TR current, voltage as well as the TR contactor position indications are sent to the ECAM system via System Data Acquisition Concentrator (SDAC) 1 and 2.

UGB13131 - U7ST0M0 - UM24DR000000001



GENERAL ... TR 1 NORMAL CONFIGURATION

TRANSFORMER RECTIFIER D/O (3)

TR 1 ABNORMAL CONFIGURATION

In the event of a TR 1 fault detection, the DC BUS 1 control contactor (5PU1) is no longer energized. The fault signal is sent to the ECAM system, the Centralized Fault Display Interface Unit (CFDIU) and the DC normal generation switching system (1PC1 & 1PC2).

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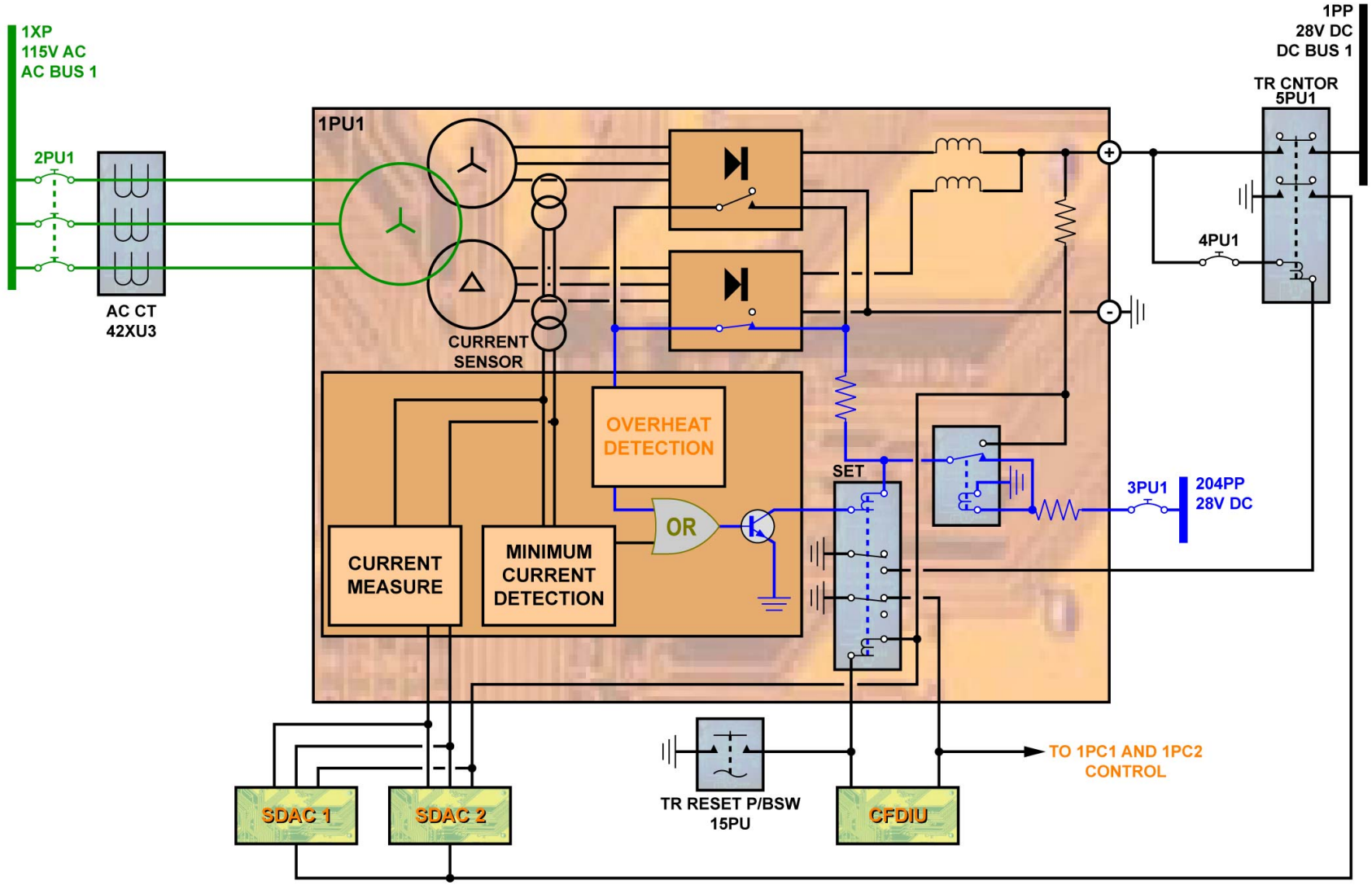

TR 1 ABNORMAL CONFIGURATION

TRANSFORMER RECTIFIER D/O (3)

TR 1 RESET CONFIGURATION

When the fault disappears, the TR remains deactivated. Reset action is necessary for TR reactivation. The TR protection reset is possible either from MCDU via CFDIU or from the guarded toggle switch located in the battery compartment.

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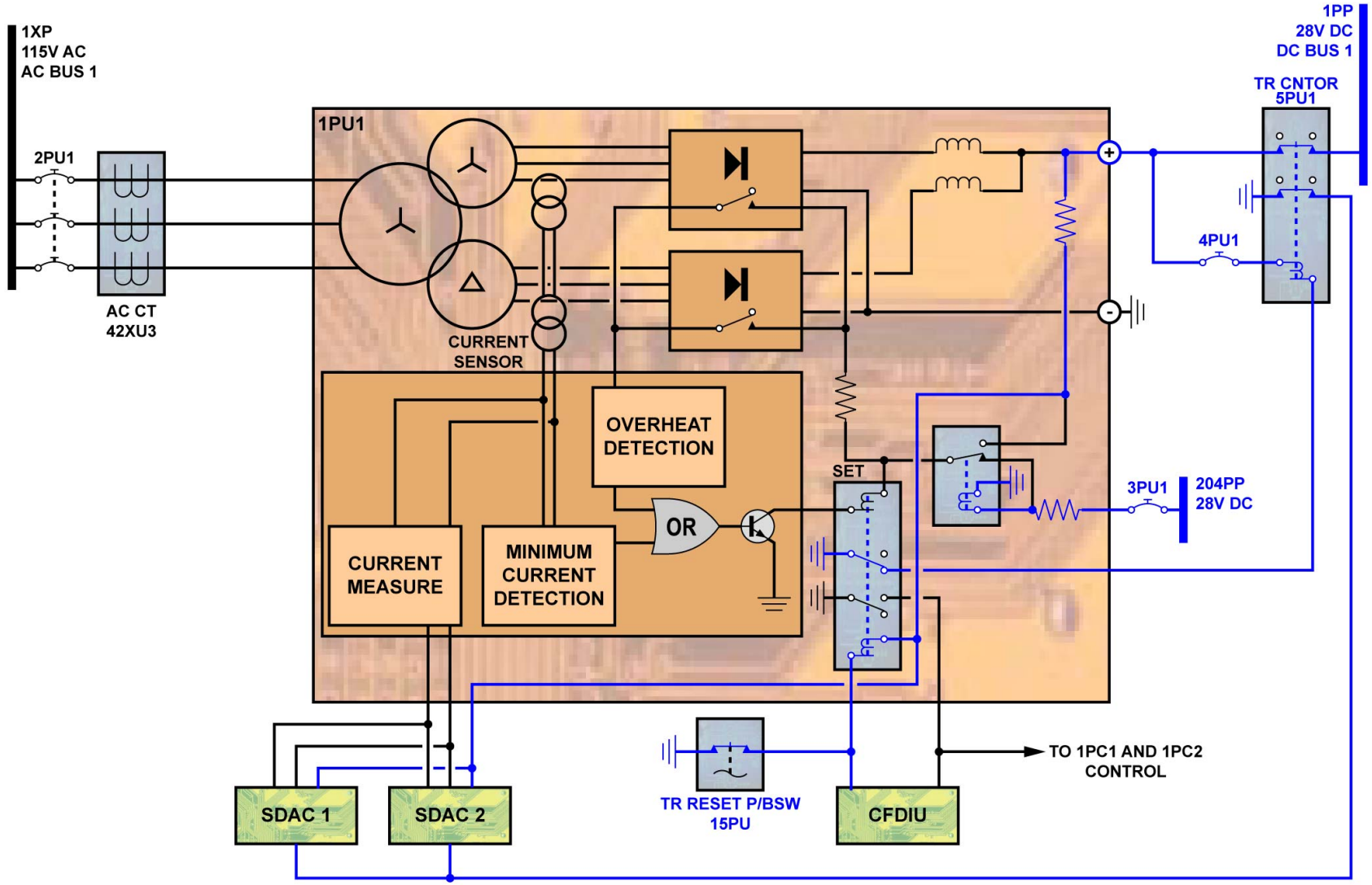

TR 1 RESET CONFIGURATION

TRANSFORMER RECTIFIER D/O (3)

TR 2 OPERATION

The operation of TR 2 is identical to that of TR 1. When AC and DC GrouND FLighT buses are only supplied by EXTernal PoWeR, the TR 2 minimum current detection system is inhibited. The contactor AC & DC GND SerViCE SupPLY 14XX is controlled by the MAINTenance BUS switch (5XX) on the panel 2000VU set to the ON position, to be in maintenance configuration.

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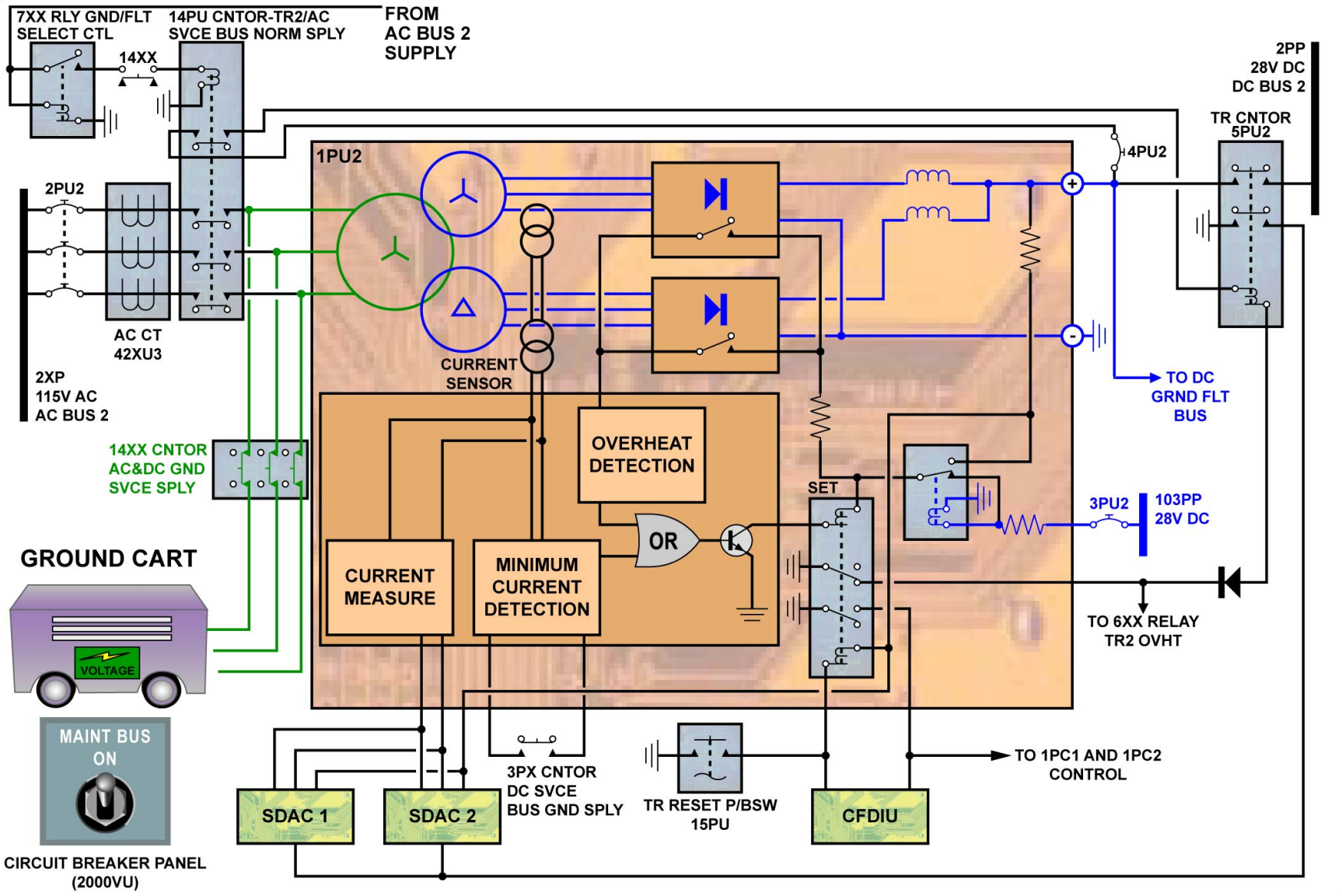

TR 2 OPERATION

TRANSFORMER RECTIFIER D/O (3)

ESSENTIAL TR OPERATION

The ESSential TR operation is identical to that of TR 1 and TR 2. ESS TR fault signal is sent to Flight Warning Computer (FWC) 1 and 2.

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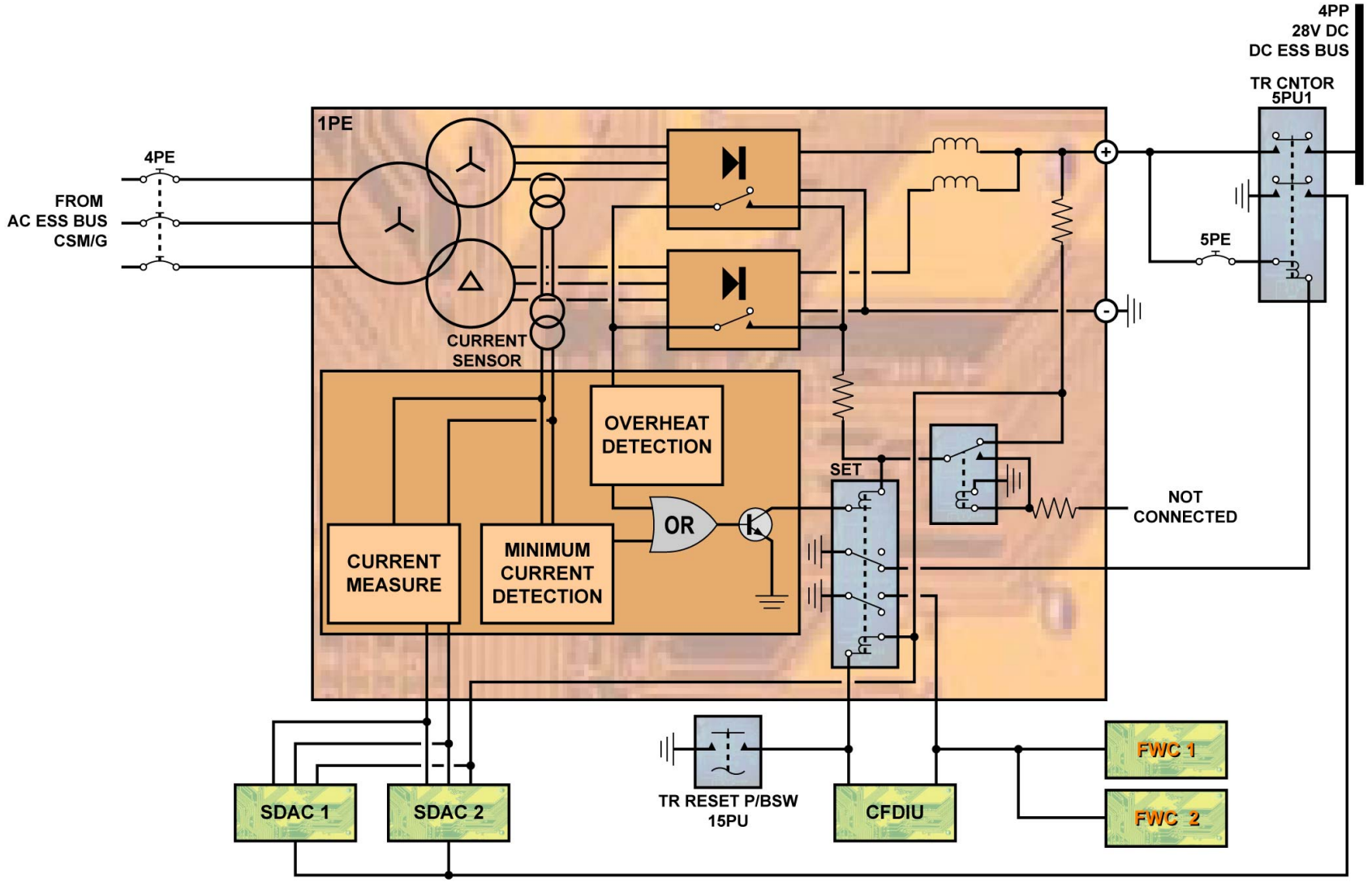

ESSENTIAL TR OPERATION

BATTERY SYSTEM D/O (3)

GENERAL

The battery system is composed of two batteries, which are mainly used to start the APU and supply AC and DC essential network in emergency configuration. Each battery is associated to one Battery Charge Limiter (BCL). The BCL ensures battery charge and battery protection by controlling the battery contactor.

BATTERY DESCRIPTION

The two batteries are identical and interchangeable. Each battery is ventilated by two ducts. The differential pressure between the cabin and the outside is used to provide battery ventilation. Each battery has 20 Nickel-Cadmium cells in a stainless steel case. Each battery has a nominal voltage of 24V DC and a nominal capacity of 23 Ah.

BATTERY CONTROL

Each battery is associated to a BCL, which is controlled by the corresponding BATtery P/BSW. When the BAT P/BSW is pressed-in (AUTO position), the BCL controls the battery coupling/uncoupling. When released-out, the battery is uncoupled from the network and the white OFF light comes on.

NOTE: In flight, in normal configuration, the batteries are isolated from the network by its respective BCL.

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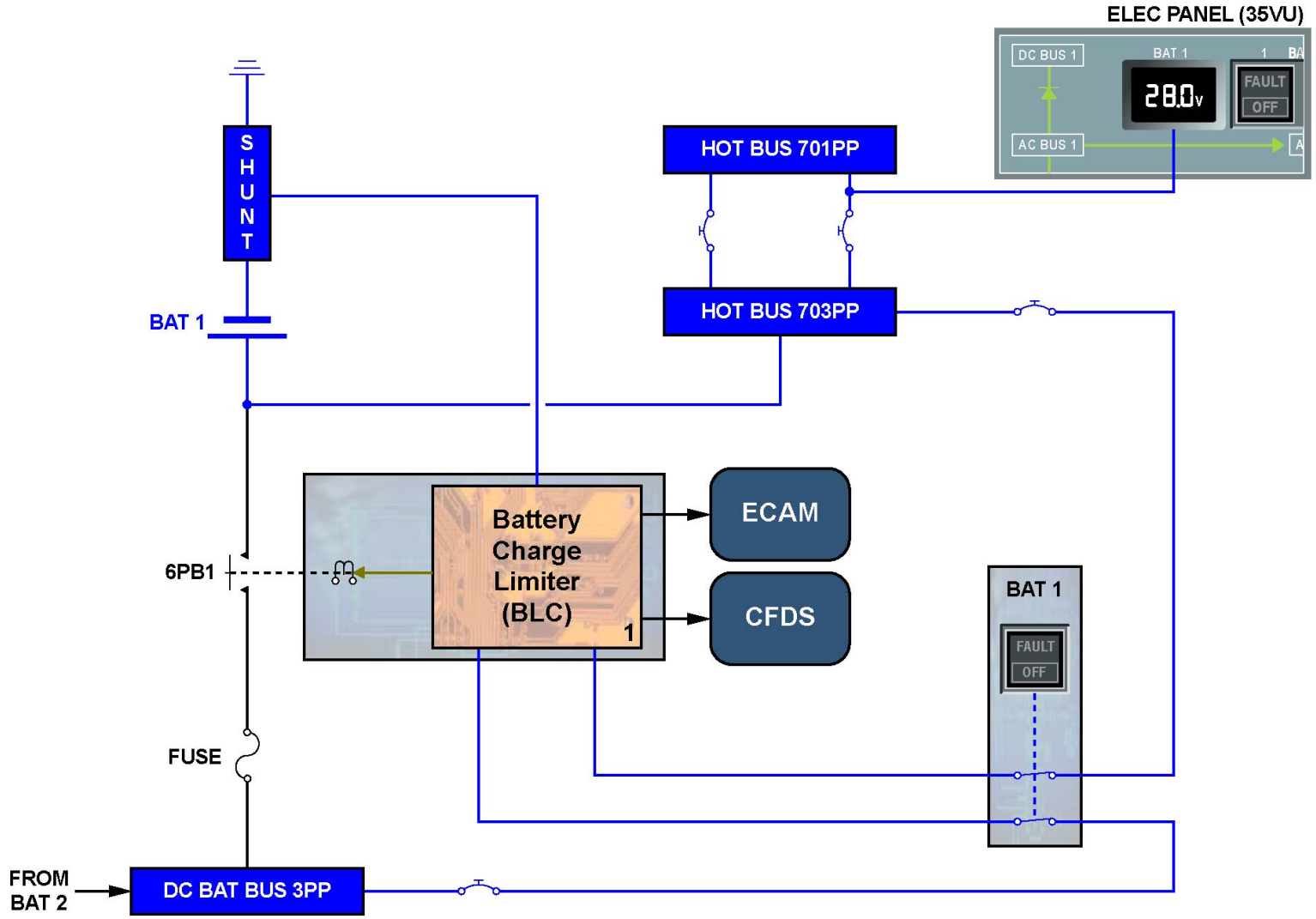

GENERAL ... BATTERY CONTROL

BATTERY SYSTEM D/O (3)

INDICATING/MONITORING

Battery parameters such as voltage and current are displayed by the ECAM. Warnings also appears on the ECAM. The voltmeters, located on the main ELECtrical control panel, give battery voltage indication (HOT BUS) even in cold aircraft configuration. The BCLs monitor the charge of the batteries. In the event of battery thermal runaway or internal short-circuit, the battery is isolated, the amber FAULT light comes on and the ECAM system is activated. System failures and BITE data are sent to the Centralized Fault Display System (CFDS).

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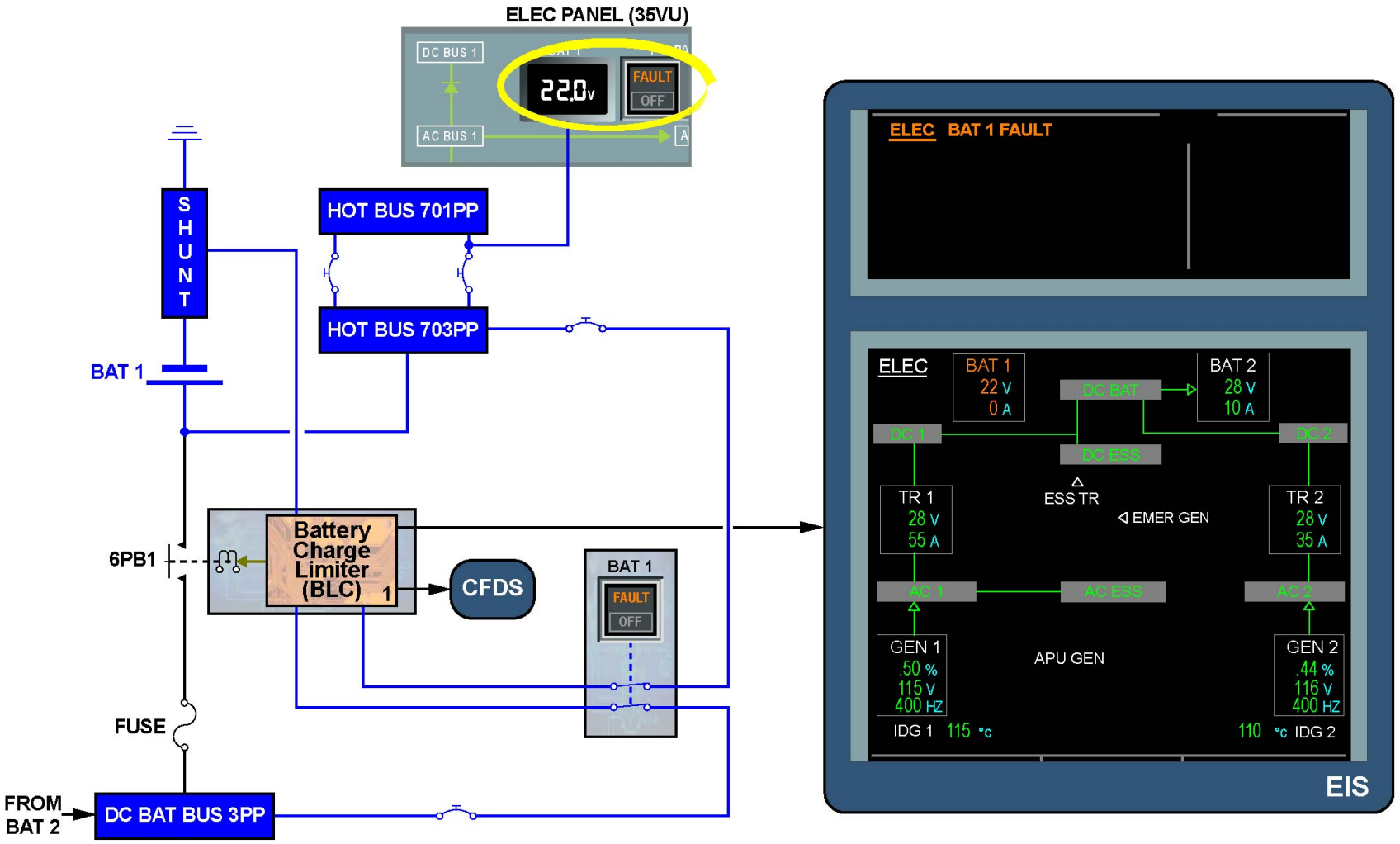

INDICATING/MONITORING

BATTERY CHARGE LIMITER D/O (3)

GENERAL

The two Battery Charge Limiters (BCLs) are identical and interchangeable. Pin programming determines the position of the BCL and the aircraft type.

PURPOSE

The main function of the BCL is to control the battery contactor and BATtery FAULT warning. Also, BCL 1 and BCL 2 control the EMERgency GENerator FAULT warning. The battery contactor control includes the following functions:
- protection of the battery against thermal runaway or short circuit,
- ensuring battery charging,
- preventing complete discharge,
- ensuring integrity of the HOT BUS,
- assisting the APU starting.

NOTE: BCL 1 and 2 also ensure battery power supply to part of the network during transient configuration or on ground when no normal power is available.

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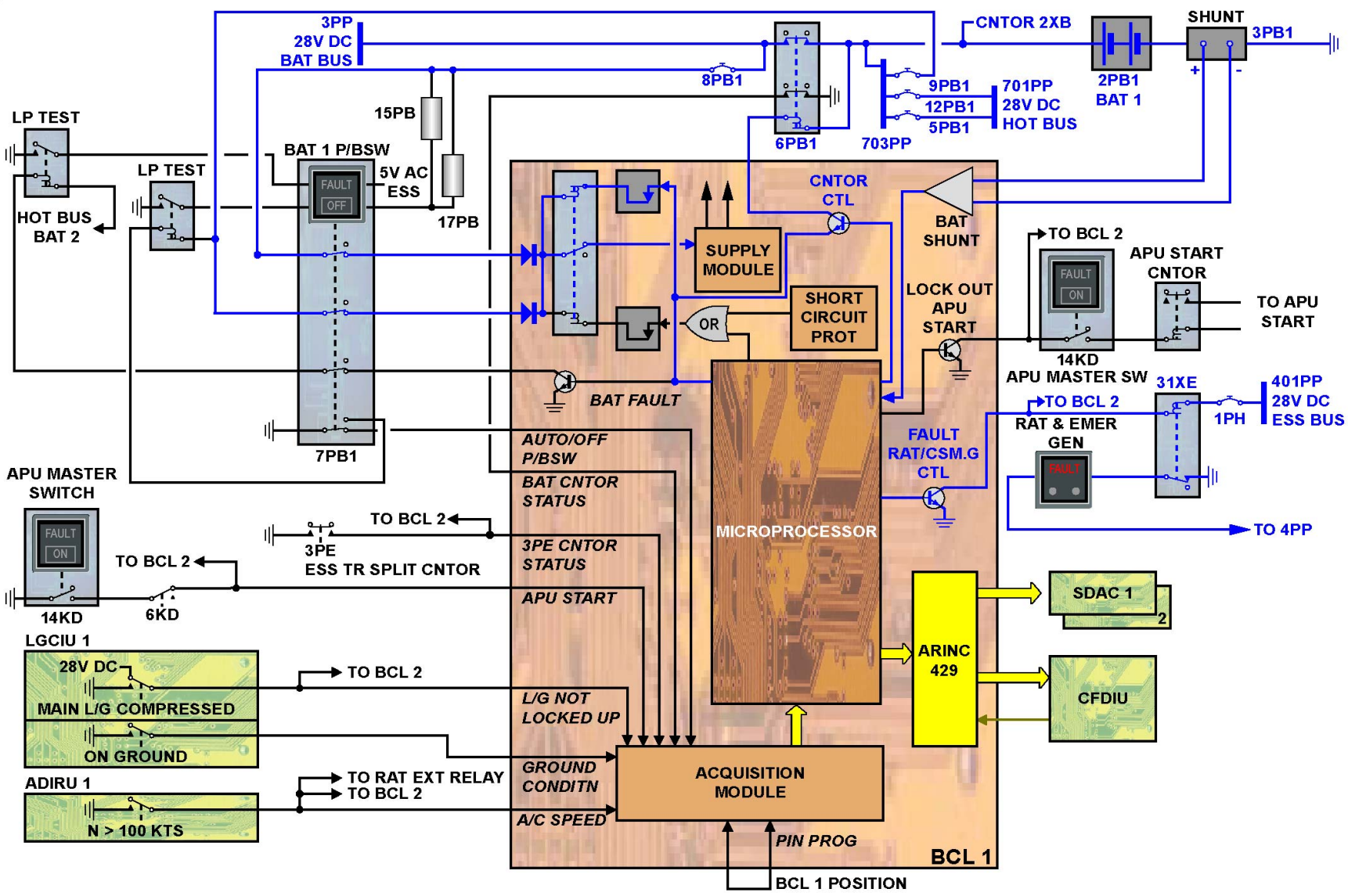

GENERAL & PURPOSE

BATTERY CHARGE LIMITER D/O (3)

BATTERY CHARGE (BAT P/BSW PRESSED IN)

When battery voltage is lower than 26.5V DC and BAT BUS voltage is higher than 27V DC (checked by the acquisition module), the battery is connected via contactor 6PB1. When the charge current sensed by the battery shunt is less than 4 A decreasing for 10 s on ground or 30 min in flight or following APU start, the battery is fully charged, the contactor opens and the battery charge stops.

HOT BUS PROTECTION

In order to maintain the HOT BUS supply, the contactor 6PB1 opens under these conditions:
- discharge current greater than 100 A for 300 ms,
- discharge current greater than 400 A for 5 ms.

THERMAL RUNAWAY OR SHORT CIRCUIT PROTECTION

If the charge current is above 10 A and increasing by more than 0.375 A per minute or the charge current is greater than 150 A for 90 s, the contactor 6PB1 opens. The short circuit hardware protection detects the malfunction of the battery and stops the supply of the BCL.

COMPLETE DISCHARGE PROTECTION

On ground, when the battery voltage is lower than 23V DC for 15 s, the BCL supply contactor opens automatically.

EMERGENCY CONFIGURATION

The batteries are connected to the BAT BUS after landing in emergency configuration. The battery contactors 6PB1 and 6PB2 are closed by BCLs when the aircraft speed is lower than 100 kts.

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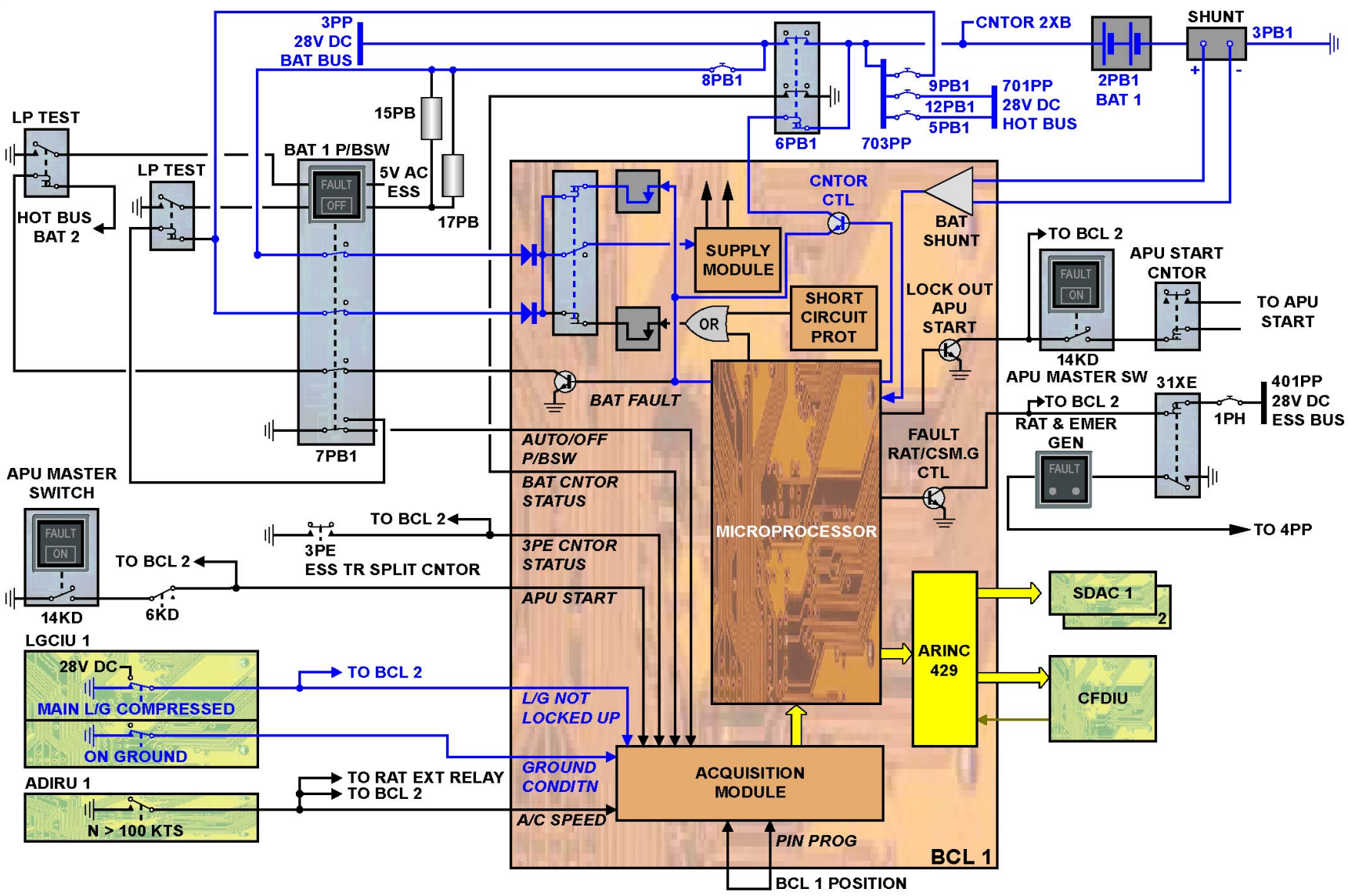

BATTERY CHARGE (BAT P/BSW PRESSED IN) ... EMERGENCY CONFIGURATION

BATTERY CHARGE LIMITER D/O (3)

APU START

The APU can be started by the batteries alone or by the normal supply. When the APU start sequence is initiated by setting the APU MASTER SWitch to ON, batteries are connected to 28V DC BAT BUS in order to withstand the high APU starter motor demand. When the APU start sequence is complete (50% N1), relay 6KD closes to interrupt the APU START signal. In flight, in electrical emergency configuration, the APU start sequence is locked out during 45 s or until the Constant Speed Motor/Generator (CSM/G) is connected to the network.

EMER GEN FAULT CONTROL

In emergency configuration, if the CSM/G is inoperative or during transient configuration, the RAT & EMER GEN FAULT legend on the EMER ELECtrical PoWeR panel comes on, controlled by BCL 1 and 2.

BAT FAULT CONTROL

In case of thermal runaway or short circuit, the FAULT legend of the BAT P/BSW comes on. An amber message and the ELEC page are displayed on the ECAM, the MASTER CAUTion lights come on and the Single Chime (SC) sounds.

NOTE: The 5V DC for the OFF light are delivered via 15PB and 17PB resistors.

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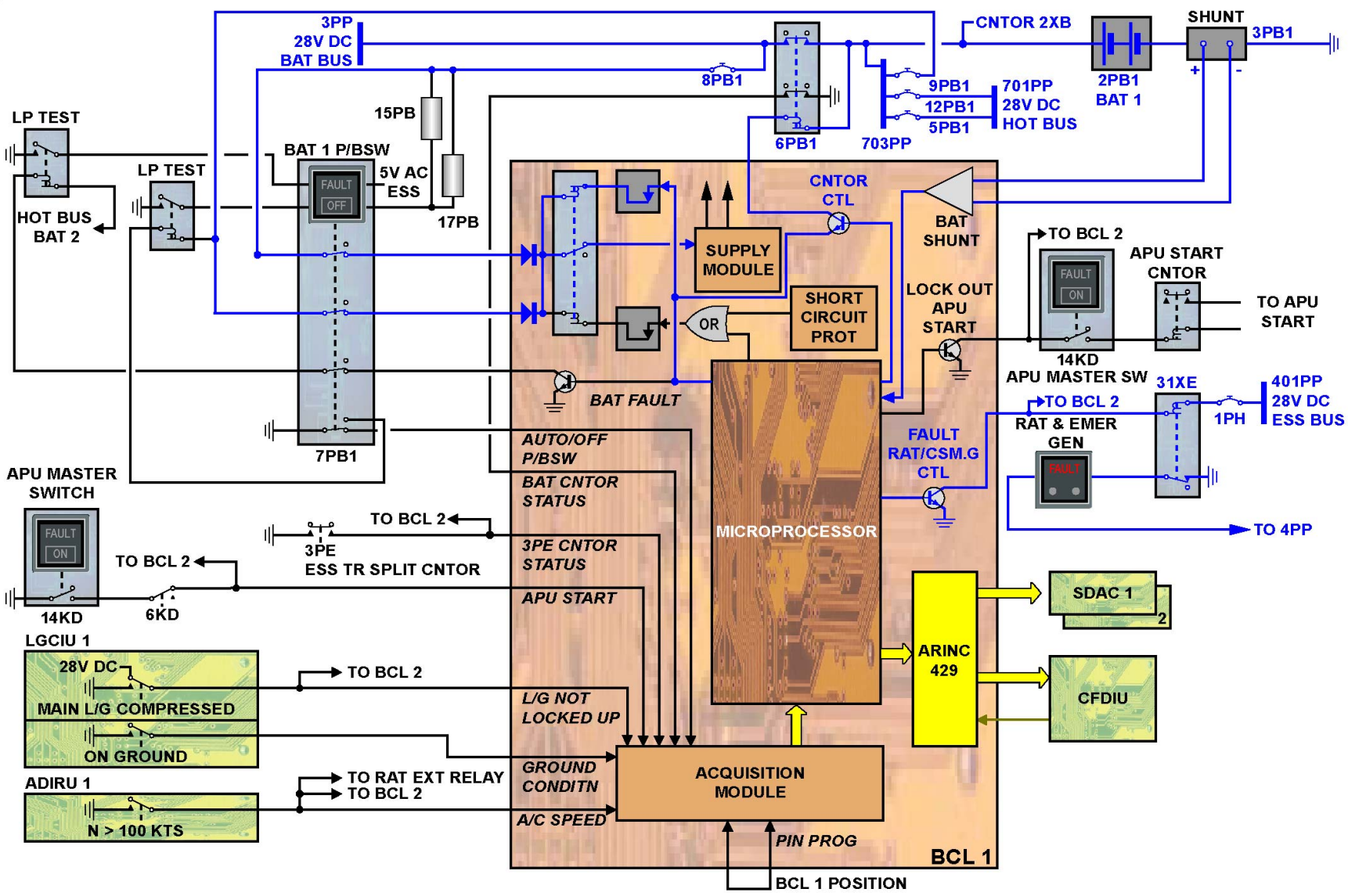

APU START ... BAT FAULT CONTROL

ELECTRICAL POWER SYSTEM OPERATION, CONTROL & INDICATING (3)

IDG DISCONNECTION and RAT EXTENSION

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